THE ENGINEER

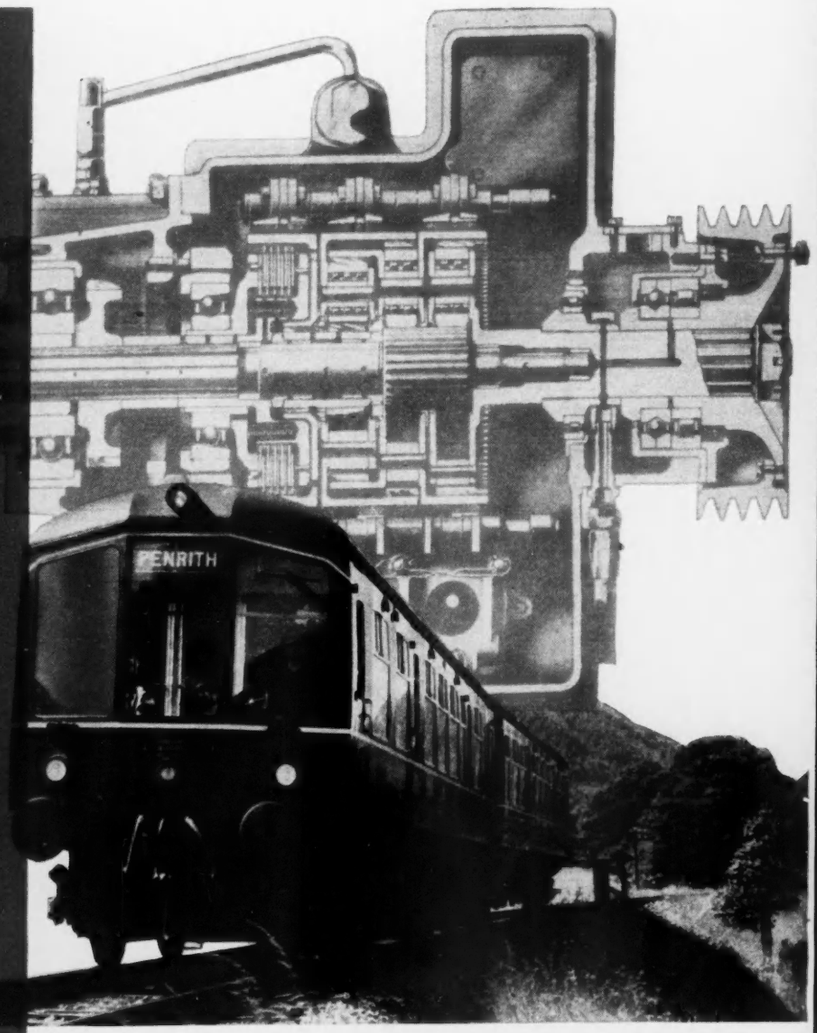
JUNE 19, 1959 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

NICKEL ALLOY STEELS

ensure reliability in gear changing

The self-changing gear box, produced by Self-Changing Gears Ltd., Coventry, is standard on road, rail and waste transport in many lands, and notably on London buses.

This famous unit, in both its pre-selector and fully automatic versions, incorporates a range of nickel alloy steels. Although there is no direct mechanical operation of the gears in the normal way, heavy train, truck and bus operation inevitably imposes severe stresses upon the gears. To withstand these stresses most of the operating mechanism in the 'Wilson' box is made from nickel alloy steels, including the 3 per cent nickel-chromium-molybdenum EN 36 case-hardening steel.



TYPICAL CORE MECHANICAL PROPERTIES OF

EN36

The benefits to be gained from the more highly alloyed case-hardening nickel steels, such as EN 33, EN 34, EN 36 and EN 39 include ease of heat-treatment, minimisation of processing distortion, and general reliability.

SIZE	HEAT TREATMENT	MAXIMUM STRESS t.s.i.	ELONGATION per cent	IZOD ft. lb.
1 1/8" dia.	Oil quenched 780 C.	72·0	19	69
2 1/8" dia.	Oil quenched 860 C. Oil quenched 780 C.	62·7	19	67
3" dia.	Oil quenched 860 C. Oil quenched 780 C.	59·7	22	72

MOND NICKEL

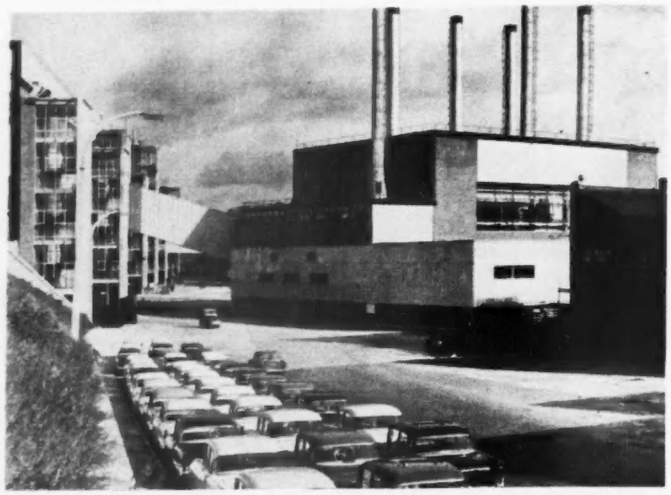
Send for 'The Mechanical Properties of Nickel Alloy Steels' ▶

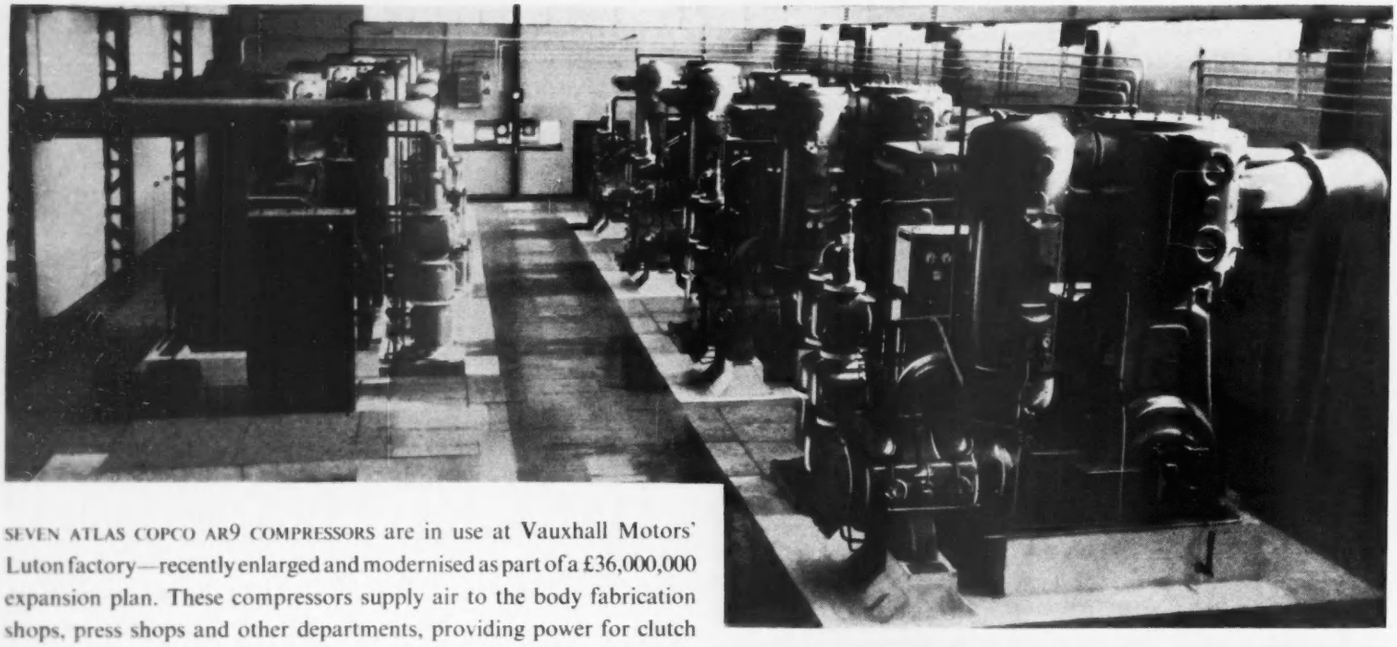
THE MOND NICKEL COMPANY LIMITED

THAMES HOUSE, MILLBANK, LONDON, SW1

TGA 21/2R

Compressed Air at work in Vauxhall's Luton extension





SEVEN ATLAS COPCO AR9 COMPRESSORS are in use at Vauxhall Motors' Luton factory—recently enlarged and modernised as part of a £36,000,000 expansion plan. These compressors supply air to the body fabrication shops, press shops and other departments, providing power for clutch movements; resetting presses; mechanical handling; loading; welding; and mixing and spraying paint. In addition air is supplied for a number of pneumatic tools such as wrenches, grinders, drills and hoists.

ECONOMIC INSTALLATION

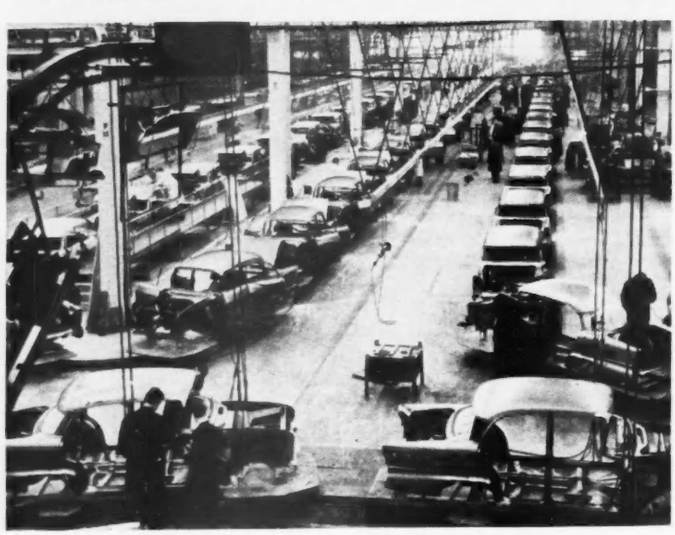
The AR9 compressors were installed at a cost below that estimated for other compressors of the same capacity. The reason being that the AR9 occupies 25% less floor space than is normally required—with consequent economies in compressor house costs.

HIGH OUTPUT

The Atlas Copco AR9 combines thorough reliability of performance with unusually high output per horsepower consumed. The installation at Vauxhall's has a total output of 22,540 c.f.m.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.



Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco AB, Stockholm 1, Sweden or Atlas Copco (Great Britain) Limited, Maylands Avenue, Hemel Hempstead, Herts.

C.16

THE ENGINEER

Established 1856

No. 5395 JUNE 19, 1959 VOL. 207

EDITORIAL CONTENTS

Leading Articles	The Printing Dispute	941
	Trawsfynydd Nuclear Power Station	941
	Revival of Venetians	942
Articles		
	100 Years Ago	942
L. O. Whittaker	Nitrogen Factory at Stanford-le-Hope	943
	Ground Effect Aircraft	946
	St. Lawrence River Development. No. IV	947
G. W. Tripp	Car Ferry for Continental Services	950
	Corrosion Engineers' Association	953
	Cobalt Container for Industrial Radiography	954
	Birthday Honours	955
	Metropolitan Line Modernisation	955
	British Iron and Steel	955
	Trawsfynydd Nuclear Power Station	955
	Tests on Berkeley Reactor Pressure Vessel	956
	Groove and Deep Bore Gauges	956
	Stable Low-Friction Resin	957
	Self-Propelled Drilling Rig	957
	Porous Plastics	957
	Electrolytic Conductivity Recorder	957
Continental Section		
	Centralised Signalling System for Swedish Line	958
	Nuclear Power in Southern Italy	958
	Large Slab Shear	959
American Section		
	Neutron Physics Research at the National Bureau of Standards	960
LETTER	Freeing an End of a New Motorway	953
BOOK REVIEW		953
OBITUARY	A. Treve Holman	953
NEWS AND NOTES	Personal and Business	963
	British Standards Institution	963
	British Patent Specifications	964
	Launches and Trial Trips	964
	Forthcoming Engagements	964
	Advanced Engineering Courses	964

32-PAGE SUPPLEMENT—Swiss Achievements

INDEX TO ADVERTISERS : PAGE 75 **CLASSIFIED ADVERTISEMENTS : PAGE 67**

NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

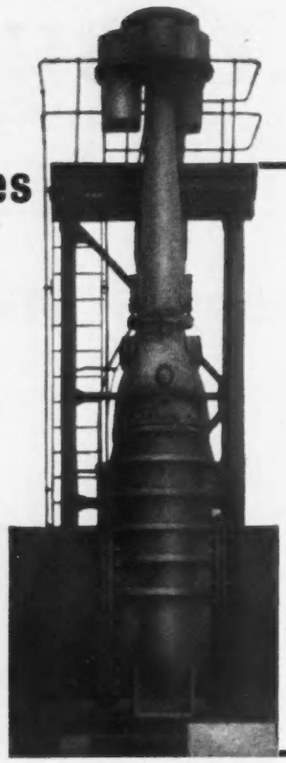
Published every Friday by

MORGAN BROTHERS (PUBLISHERS) LTD., at 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone : CENtral 6565

Northampton

relies on Bailey's valves

At the Northampton Power Station, Bailey valves control the water supply for the cooling system. Backed by more than a century's experience the company provides a standard range of high quality valves from 2 to 54 inch bore for pressures up to 150 p.s.i., for the control of oil, water, steam or gas. Advice is gladly given on all kinds of applications and a special Contracts Department is maintained to deal with valve schedules on large contracts anywhere in the world.



A FEW OF THE INSTALLATIONS USING BAILEY'S VALVES

Malacca Power Station
Basra Power Station
Baghdad Refinery
Mond Nickel Refinery
Penang Power Station
Selkirk (Manitoba) Power Station
Barbados Power Station
Barri Sudan
Colenso Power Station
Kuwait Refinery
Roxburgh Power Station

MOST OF THE C.E.G.B. POWER STATIONS AND A.E.A. STATIONS INCLUDING

Battersea, Bold, Bradwell, Calder Hall, Chapelcross, Hams Hall, High Marnham, Littlebrook, Marchwood, Northampton, Nottingham, Staythorpe, Stella North, Stella South, Willington

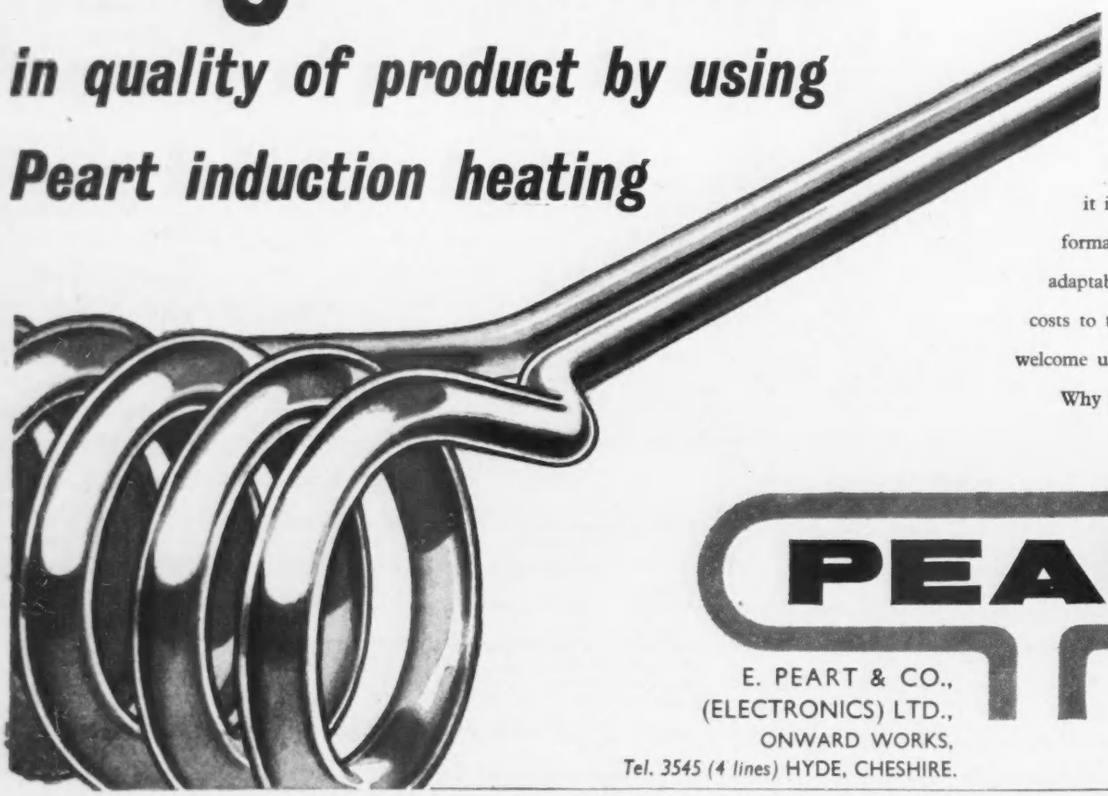
Bailey's VALVES

SIR W. H. BAILEY & CO. LTD. HEAD OFFICE & WORKS: PATRICROFT, MANCHESTER
TELEPHONE: *Eccles* 3487-8-9 GRAMS: *Beacon, Telex, Eccles.* LONDON OFFICE: Selinas Lane, Dagenham, Essex. *DOMinion* 2277-8-9
SLUICE VALVES • PRESSURE REGULATORS • TEST PUMPS • TURNSTILES

TGA BAI I

Forge Ahead

in quality of product by using Peart induction heating



Peart Induction heaters cut costs all along the production line. They provide the exact amount of heat precisely where it is required . . . . . eliminate scale formation, increase die life, are easily adaptable . . . reduce power and labour costs to the minimum. Peart engineers welcome unusual heat treatment problems. Why not set them to work on yours.

PEART

E. PEART & CO.,
(ELECTRONICS) LTD.,
ONWARD WORKS,
Tel. 3545 (4 lines) HYDE, CHESHIRE.

INDUCTION HEATING

15 contracts from Hoover Ltd endorse the supremacy of

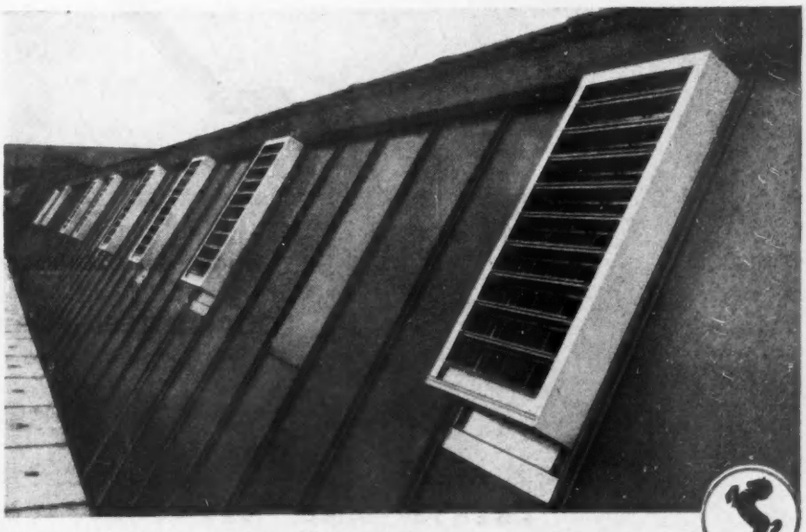
COLT

VENTILATION

Time and time again, industrialists large and small call in Colt. And for three good reasons. Colt ventilation systems depend in the main on internal convection currents—*not* external forces—and are therefore little affected by the vagaries of the wind. Colt offer an unparalleled range of ventilators. And most important, every Colt recommendation is based on a thorough analysis of the building, plant and process either from a site survey or drawings. Such thoroughness influences firms such as Hoover Ltd. It will impress you, too. Ask your secretary to send for a free manual to Dept. S28/6B

Among the 12,000 major Industrial Organisations using Colt equipment are:

9 contracts: *Joseph Lucas Ltd.*
56 contracts: *de Havilland Aircraft Co. Ltd.*
20 contracts: *Courtaulds Ltd.*
11 contracts: *Dunlop Rubber Co. Ltd.*
7 contracts: *Richard Thomas & Baldwins Ltd.*
11 contracts: *Steel Company of Wales Ltd.*
15 contracts: *United Kingdom Atomic Energy Authority.*
37 contracts: *Vickers-Armstrongs (Aircraft) Ltd., Weybridge.*



COLT CO2046 VENTILATORS AT HOOVER LTD., HIGH WYCOMBE

COLT VENTILATION LIMITED · SURBITON · SURREY · TELEPHONE: ELMBRIDGE 0161 (10 LINES)

TRADE MARK

HIGGS MOTORS LTD.

MANAGING DIRECTOR DAVID C.Y. HIGGS, A.M.I.E.E.

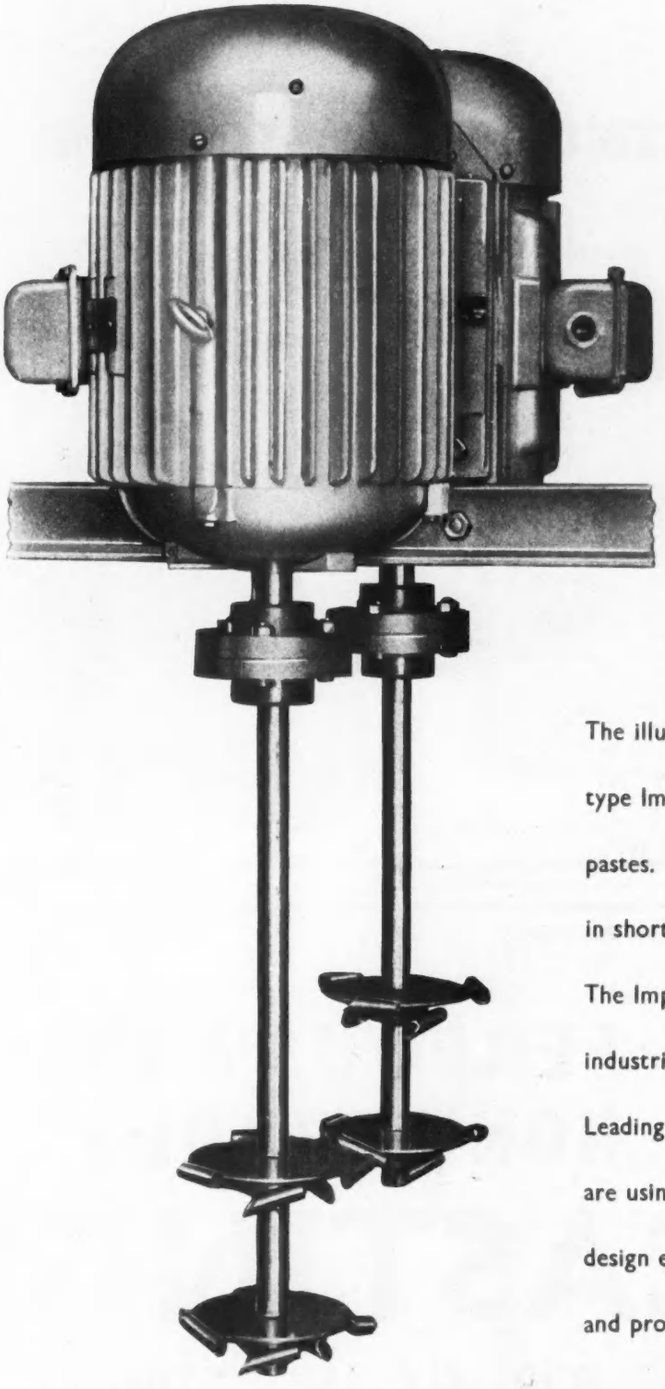
BIRMINGHAM 6 ENGLAND

FRACTIONAL HORSEPOWER MOTORS
including
LOW SPEED GEAR UNITS

OTHER MACHINES UP TO 1000 H.P.

GUARANTEED FOR EVER

AGENTS AND BRANCHES COVER THE WORLD



Controlled Mixing with PLENTY IMPELATORS

The illustration shows a pair of Plenty industrial type Impelators as supplied for the mixing of graphite pastes. They give a more efficient mix in shorter time on one of the most difficult applications. The Impelator can be adapted to meet any industrial mixing problem, whether large or small. Leading firms in this country and the U.S.A. are using Plenty Impelators and the services of Plenty design engineers with conspicuous success and profit. Fullest details gladly sent on request.

Some Users—

Imperial Chemical Industries Ltd.
Caltex Services Ltd.
Cadbury Brothers Ltd.
Colgate-Palmolive Ltd.
Guest Keen Iron & Steel Co., Ltd.
English Clays Lovering Pochin & Co., Ltd.
Scribbans-Kemp Ltd.
British Nylon Spinners Ltd.
Kodak Ltd.
Ever-Ready Co. (Gt. Britain) Ltd.

PLENTY & SON Ltd.

Eagle Iron Works, NEWBURY, BERKS, Eng.

Telephone: NEWBURY 2363 (4 lines)
Telegrams: PLENTY, NEWBURY

EN

Thompson

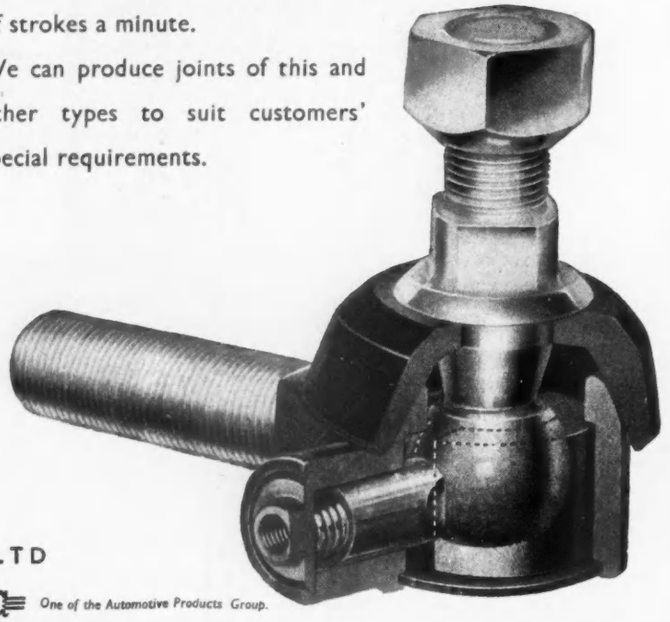
SELF-ADJUSTING BALL-JOINTS

These joints are self-adjusting and are very well made from fine materials. Used extensively on steering connections for every class of road vehicle, they are also valuable in a great many applications in general engineering, where their use can often save specially-made joints and at the same time give an improved result by eliminating backlash.

A SPECIAL-PURPOSE JOINT

The illustration shows a 1" eccentric-type self-adjusting joint. This forms the crank-pin and big-end bearing of a crank operating the cutter bar of a mower, at many hundreds of strokes a minute.

We can produce joints of this and other types to suit customers' special requirements.



AUTOMOTIVE PRODUCTS COMPANY LTD
LEAMINGTON SPA, WARWICKSHIRE

One of the Automotive Products Group.

GK

GUEST KEEN IRON & STEEL COMPANY

For... FERROUS AND NON-FERROUS

CASTINGS

FOR ALL INDUSTRIES

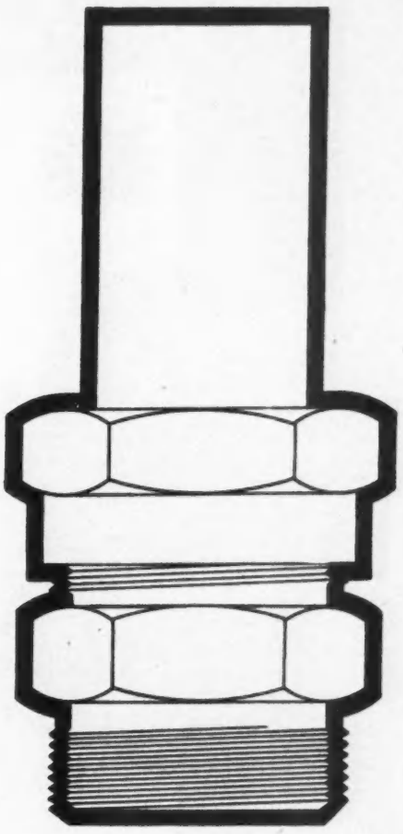
Made with the experience and skill gained by generations of craftsmen at the famous

DOWLAIS WORKS

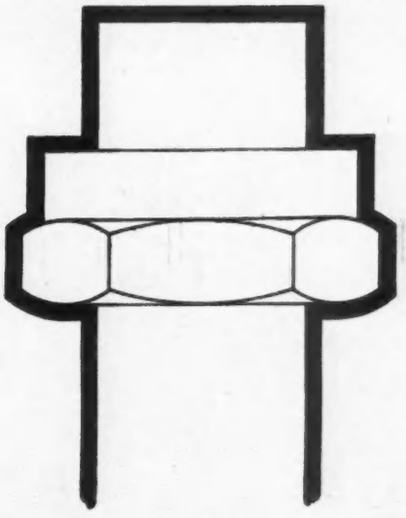
Telephone: Dowlais 70

GUEST KEEN IRON & STEEL COMPANY LIMITED

HEAD OFFICE: EAST MOORS, CARDIFF. *Phone: Cardiff 33151*



the applications of Ermeto high pressure couplings are practically unlimited



ERMETO couplings are supplied in a wide range of standard fittings for all forms of high pressure pipeline systems. Non-standard fittings can also be made to suit individual requirements. Technical advice and fully illustrated catalogue will gladly be supplied on request.

ERMETO

THE BRITISH ERMETO CORPORATION LTD

HARGRAVE ROAD · MAIDENHEAD · BERKS · TELEPHONE: MAIDENHEAD 5100

A member of the ALENCO Group of Companies

put power where you want it

Power for many purposes. Power to drive efficiently your plant or product. Power—at slow speed—single, double or triple reduction units giving 45 different gear ratios driven by motors of up to 1 h.p. Power—from sturdy dependable G.E.C. Fractional Horsepower Geared Motor Units.

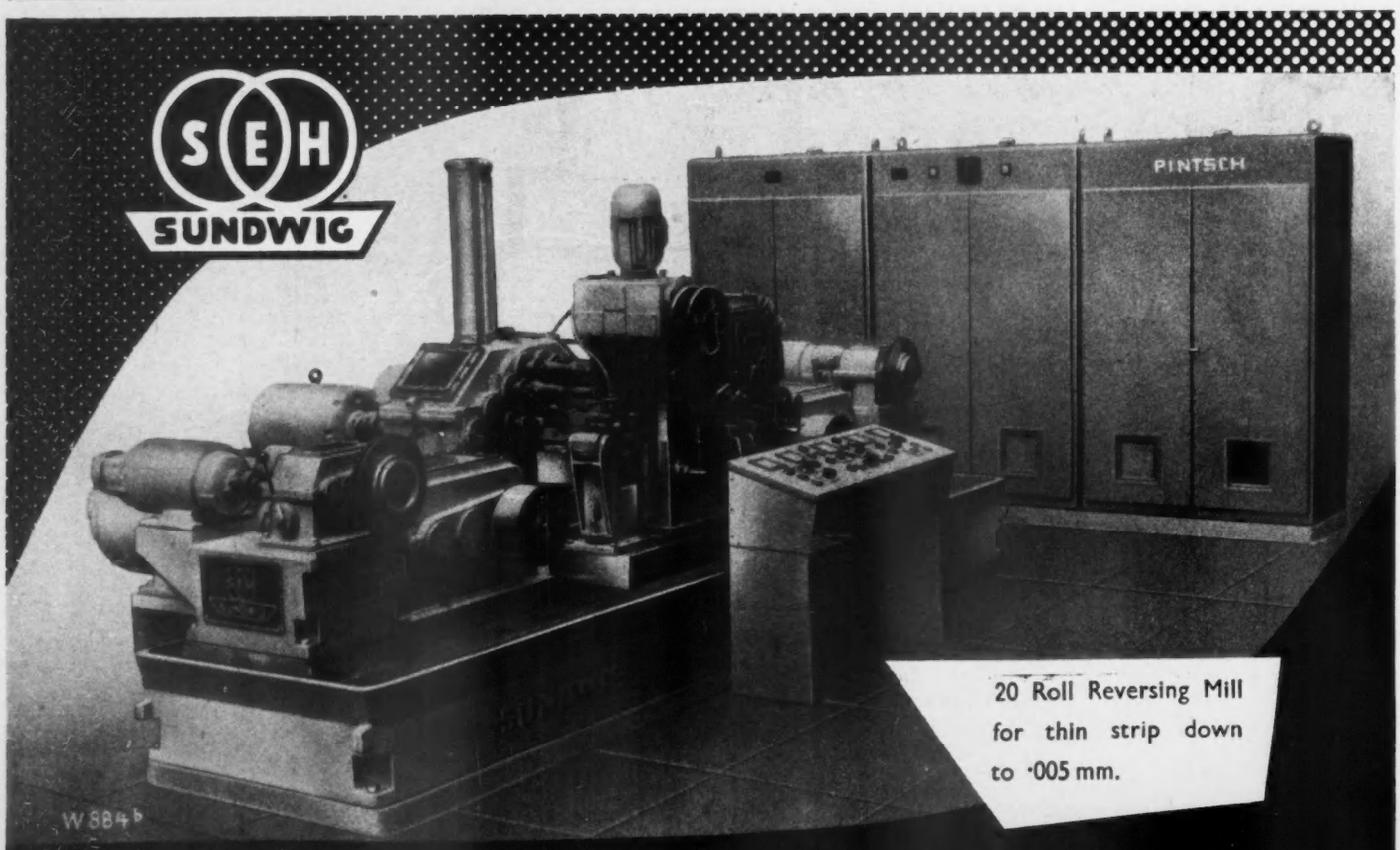
Fully detailed illustrated publication on application.

G.E.C.

fractional h.p.
GEARED MOTOR UNITS

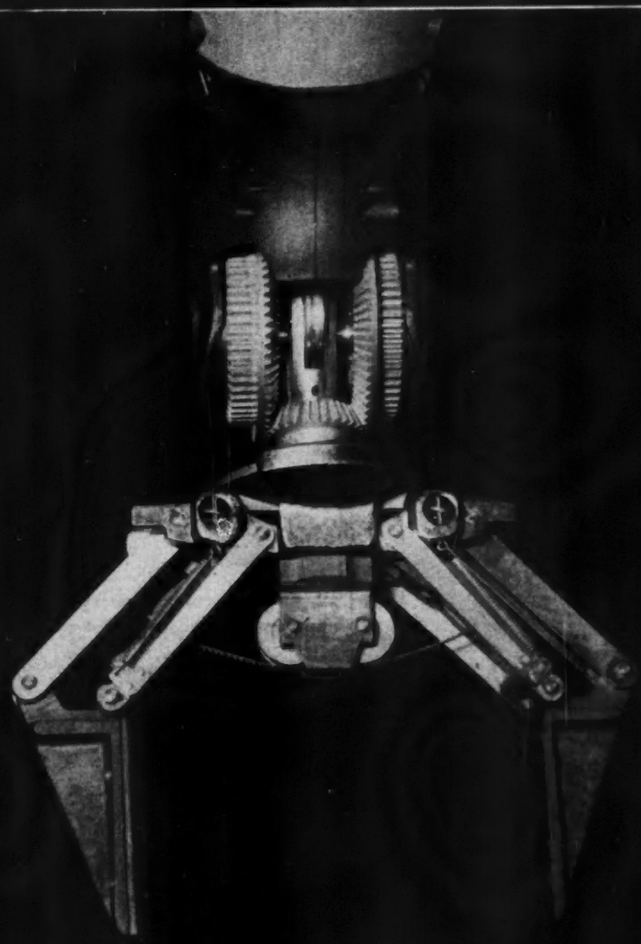
THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

S E H
SUNDWIG



20 Roll Reversing Mill for thin strip down to ·005 mm.

SUNDWIGER EISENHÜTTE MASCHINENFABRIK GRAH & CO
HEMER-SUNDWIG i. WESTF.



Manipulators

The manipulators used in atomic establishments have to operate under exacting conditions. They are constructed of stainless steel and Kanigen plated aluminium and the plate serves two functions. It resists corrosion, and because of the smoothness of the finish it also assists in decontamination of the component parts from radio-active material and the combination of stainless steel and Kanigen plated aluminium reduces the electro potential difference between the component parts. These manipulators, manufactured by Savage & Parsons Ltd., are supplied to users all over the world.

Kanigen

A HARD & CORROSION RESISTANT PLATE

Kanigen is used on the aluminium parts of the Tong End assembly and the Master Hand assembly.

KANIGEN is a nickel-phosphorus plate deposited by chemical reduction: thickness can be controlled to fine limits and is of complete and uniform coverage.

PROPERTIES:	
Composition	92% Nickel 8% Phosphorus
Melting Point	890°C.
Electrical resistivity	60 microohm cm.
Hardness	500-1,000 V.P.N. according to heat treatment
Coverage	Extremely uniform

Kanigen can be applied to all ferrous metals, aluminium, copper and brass. The plating plant at Oldbury has now been extended, two extra plating tanks are in operation and enquiries for jobbing plating are welcomed. Full information is available on request.

Albright & Wilson
(MFG) LTD
Kanigen Department
1 KNIGHTSBRIDGE GREEN • LONDON SW1

Kanigen is a regd. trade mark of Albright & Wilson Ltd

KANIGEN

V29/63

You can't gauge a camel...

... by its hump—or from the expression on its face for that matter. But one glance at a P & G pressure gauge reveals an instrument of quality, made by craftsmen to ensure accuracy and dependability for a very long time. This is no mirage—see one for yourself.

The range of P & G pressure gauges includes many different types to suit most applications—vacuum, combined, altitude, electric contact, differential, critical, duplex diaphragm, capsule, etc.

Write for publication No. 85

Payne & Griffiths Ltd

TUDOR WORKS · WINDMILL LANE
SMETHWICK · BIRMINGHAM

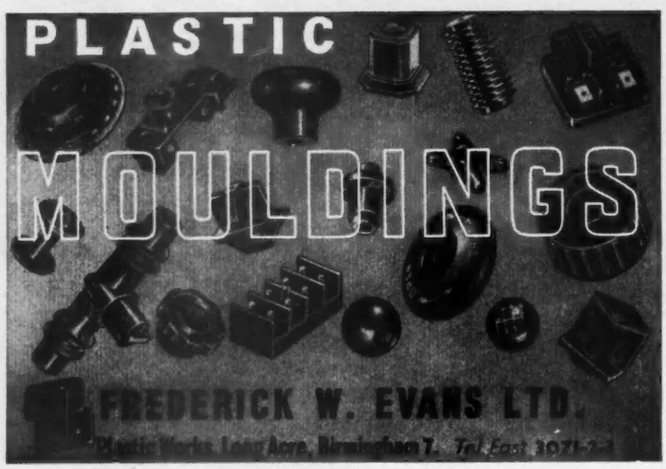
FLAMEPROOF SOLENOID OPERATED VALVES

BUXTON CERTIFIED

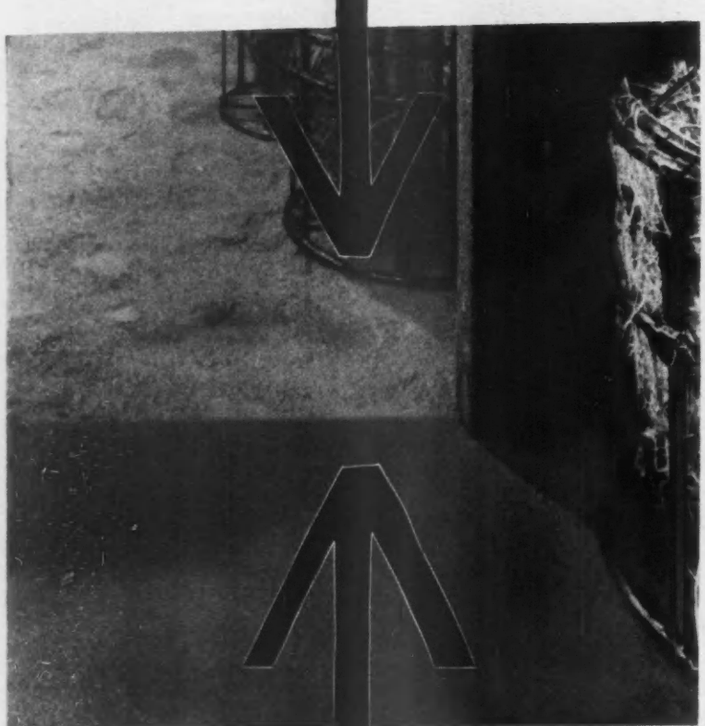
Pressure Ranges	0–5" W.G.
	0–5 P.S.I.
	0–15 do
	0–150 do
Bores ¼" to 4"	0–1500 do

Voltages D.C. 24v. to 550v.
A.C. 100v. to 600v.
WITH INTEGRAL RECTIFIERS

MAXSEAL VALVES LTD
WOOD ROAD, KINGSWOOD, BRISTOL
Phone: Bristol 67-3869



SOLVE INDUSTRIAL FLOORING PROBLEMS



Concrete Factory Floor after 3 months wear showing untreated and Ceradek treated surfaces.

WITH

Ceradek screeded surfacing is resistant to most chemicals. Dry or wet it provides a safe non-slip surface. It obviates dust hazards and can be laid in continuous, unbroken surfaces which have great resilience and high impact strength. Ceradek is light in weight and is available in four colours—Red, Blue, Green and Brown. It withstands heavy traffic; there is no shrinkage after laying and it bonds tenaciously to various surfaces (old or new concrete etc.).

Many times stronger than concrete, Ceradek is the complete, protective surfacing which offers large scale economies and hard-wearing, long life. Suitable for an almost unlimited number of industrial applications, Ceradek provides the most likely solution to your flooring problems. Our technical staff will gladly advise you on all aspects of Ceradek installations, supplying further details and quotations as required.

Ceradek SCREEDED FLOORING

Write or phone: TECHNICAL APPLICATIONS LTD.
VALLEY WORKS · MONTON ROAD,
ECCLES LANCASHIRE · Eccles 1737.

PLAN RIGHT WITH KONTITE

Use Kay's KONTITE pipe fittings and be sure of a first class job. KONTITE fittings make perfect joints at the turn of a spanner — save time, labour and costs. There are 22,000 different KONTITE compression fittings, precision-engineered in gunmetal to resist corrosion for all sizes of pipe up to 6" bore. Write for fully illustrated catalogue of the wide range of KONTITE fittings.

A member of the ALENCO *Group of Companies*

KAY & COMPANY (ENGINEERS) LIMITED · BOLTON · LANCS · TEL: BOLTON 3041 · LONDON OFFICE: 36 VICTORIA STREET · SW1 · TEL: ABBEY 2144

Consult FILTON For Rotary Unions—

Patented

Unions fitted with carbon bearings are available for temperatures over 400° F

For use on all types of Rotary and Semi-Rotary Machines for Leakproof Fluid Transfer
Standard Sizes ¼"—3" B.S.P.
Special Sizes & Designs up to 6" B.S.P.

As used by leading Engineering Companies and Government Departments

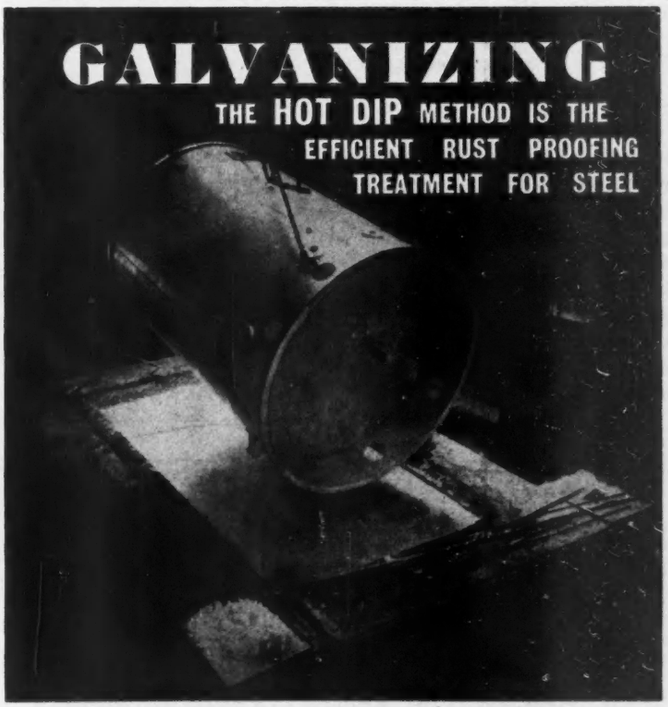
FILTON LIMITED,

CLAPHAM STREET, LEAMINGTON SPA, WARWICKSHIRE

Telephone: LEAMINGTON SPA 3111/2

GALVANIZING

THE HOT DIP METHOD IS THE EFFICIENT RUST PROOFING TREATMENT FOR STEEL



Specialists also in: **ROOF & UNDERFRAME TANKS FOR RAILWAY COACHES, DIESEL ENGINE TANKS, LIGHT CONSTRUCTIONAL STEELWORK, STEEL FABRICATION INDUSTRIAL TANKS, AND PRESSED STEEL GUTTERS.**

JOSEPH ASH & SON LTD.

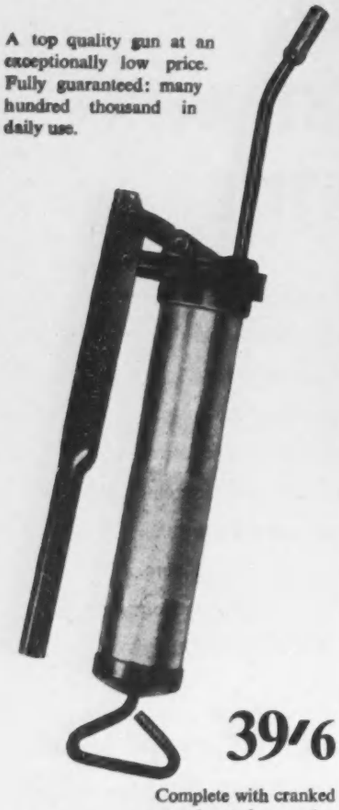
ESTABLISHED 1845

Rea Street South, Birmingham, 5.
Tel: MIDland 2441

LONDON OFFICE, 240 LEADENHALL HOUSE, 101 LEADENHALL STREET, LONDON, E.C.3.
Tel: AVEnue 1666

SWEMATIC
HIGH PRESSURE GREASE GUN

A top quality gun at an exceptionally low price. Fully guaranteed: many hundred thousand in daily use.



39/6

Complete with cranked extension pipe and hydraulic chuck, as illustrated.

★ The ideal gun for garage and workshop use. ★ Easy operation of the side lever gives pressures exceeding 6,000 lb. p.s.i. ★ For oil (SAE 90 or heavier) and all grades grease. ★ 16 oz. capacity. ★ Suction loading. ★ Valve to release airlocks. ★ All parts replaceable. ★ Black oxide and nickel finish. ★ Special terms for quantities.

HYDRAULIC GREASE NIPPLES

Made to British Standards and interchangeable with other makes. Available in bulk or in handy assortments of all popular sizes. Very keen prices.

LAWRENCE EDWARDS & CO.
(Engineers) LIMITED
KIDDERMINSTER, WORCS

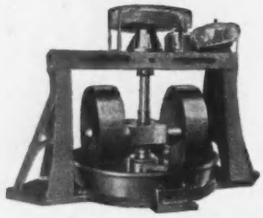
In these days of AC it is not always easy to get DC motors and generators quickly and at a reasonable price. Fortunately, EPE specialise in DC equipment, bringing years of experience to bear on the subject, so that one can always be sure of DC motors and generators, of any enclosure, at competitive prices, on short delivery. EPE are always happy to help solve DC problems, too.

E·P·E

ELECTRICAL POWER ENGINEERING CO. (B'ham) LTD.
Bromford Lane, Birmingham 8
'Phone: STEchford 2261
'Grams: Torque 'Phone Birmingham
London Office: 421, Grand Buildings, Trafalgar Square, W.C.2. 'Phone: WHitehall 5643 and 7963

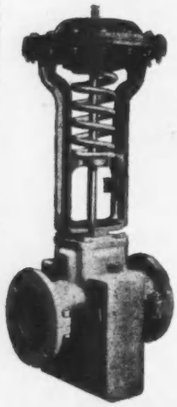
TRADE Smedley MARK

PAN GRINDING MILLS



REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN

Smedley Brothers. Ltd.
Belper. Derbyshire.
Telephone: Belper 12

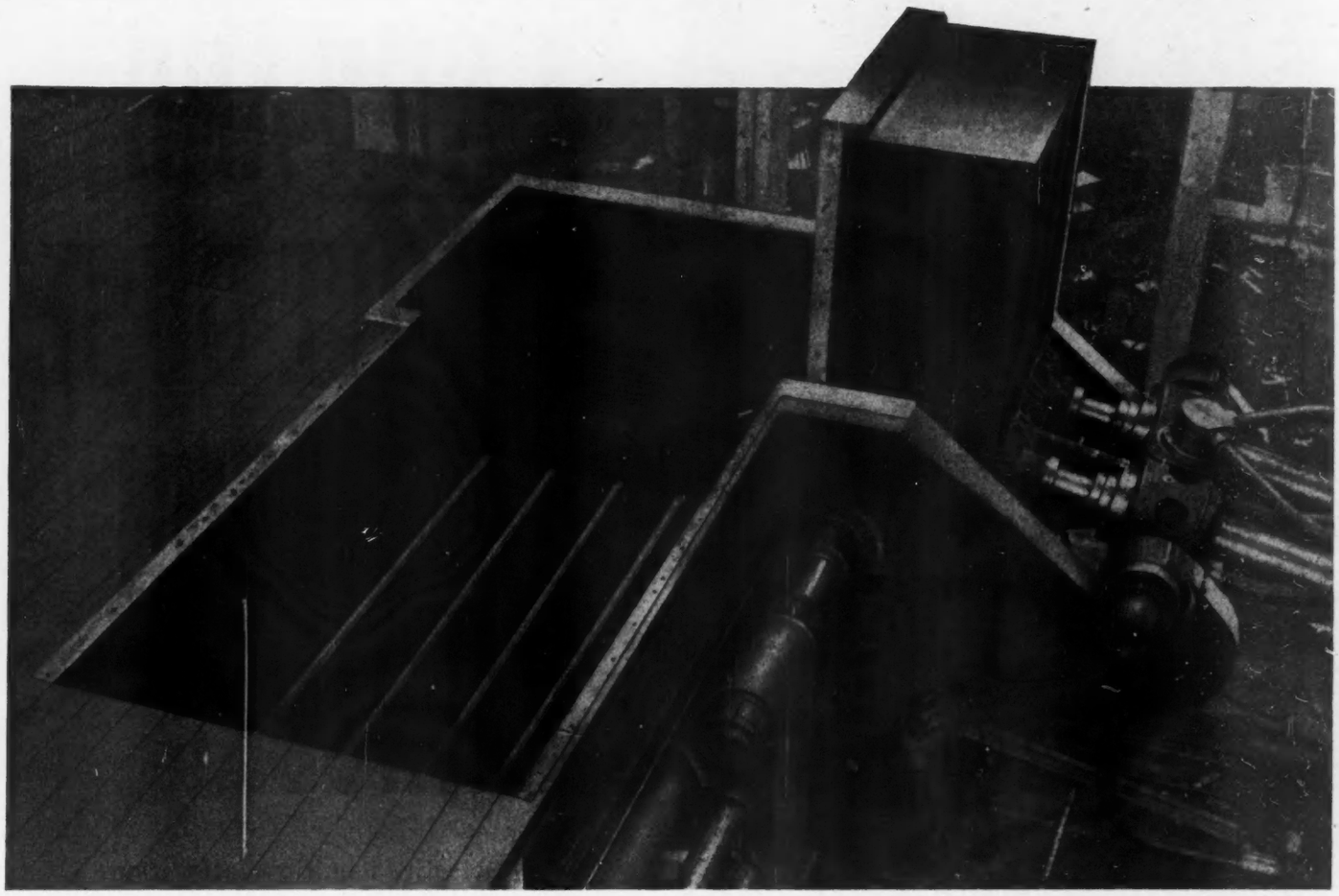


WM FLOWLINE VALVES

FLOW CONTROL PINCH VALVES

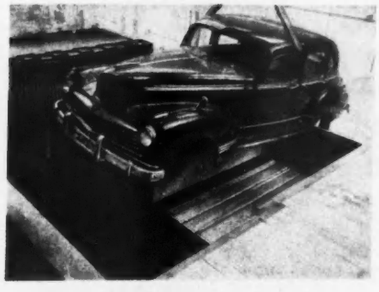
A new range of pinch valves for automatic or remote operation designed for use in conjunction with standard or special control gear. This valve combines the naturally good flow characteristics of a pinch valve with good response characteristics when used in conjunction with standard instruments; whilst not quite linear the response is markedly superior to other designs of pinch or diaphragm valves. If you prefer electric operation we can provide it.

WARREN-MORRISON LTD
41 St. James Place
London S.W.1
MAYfair 9895

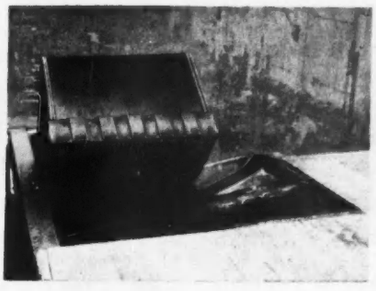


Modern Scrap Baling

Baling of a car body—more than 17 ft. long and approximately 7 ft. wide—as is shown here demonstrates particularly well the capacity of the new Lindemann Large-Volume Scrap Balers built for handling very bulky kinds of scrap.



1 With open press box lid, the large filling space accommodates one complete car body.



2 The hydraulic press box lid exerting a high pressure reduces the volume of the car body.

3 The hydraulic gatherer platen of the feeding box presses and pushes the car body into the press box.

4 By a further intermediate and subsequent final compression the bulky scrap is transformed into a bale of suitable size for furnace charging.

Our Agents in the British Isles : **MOFFAT & BELL LTD.,** 170 Piccadilly, London, W.1. Tel.: Hyde Park 9551. 466 Royal Exchange, Manchester. Tel.: Deansgate 5131.

LINDEMANN KOMMANDITGESELLSCHAFT DUSSELDORF - GERMANY

A NEW AND UNIQUE DUST EXTRACTION METHOD

SPA—Selective Particle Acceleration method of dust extraction is a revolutionary step forward in the economic removal of air pollution. Simple, highly efficient, maintenance-free and of unique design, it is a system you must investigate.

If you have a dust removal problem, have a word with Steels and 'clear the air'.

Compare these advantages with existing methods —

Unequalled collecting efficiency for a dry centrifugal collector.

Erosion is reduced to a minimum because the large particles are collected at low velocity, only the very small particles being accelerated to higher velocities necessary for collection:

Simplicity of design affords speedy, easy installation and maintenance.

Collecting range extends into the small particle sizes.

Low power consumption.

Small installation space.

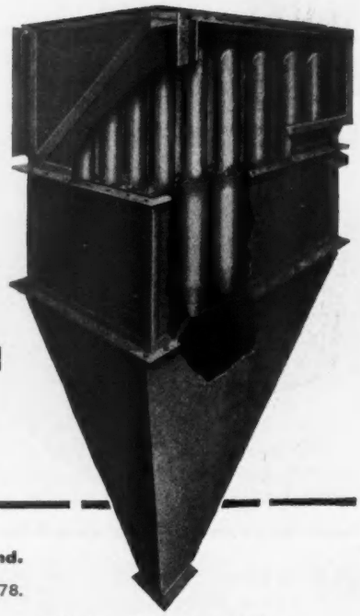
Maximum economy in product recovery.

Sturdy construction.

Factory assembly ensures dimensional precision and rigidity.

Hundreds of satisfied users throughout Europe and the U.S.A. testify to the efficiency of this system

S SELECTIVE
P PARTICLE
A ACCELERATION



STEEL

STEELS ENGINEERING INSTALLATIONS LTD., Crown Works, Sunderland, England.

HOME SALES OFFICE: 143 Sloane St., London, S.W.1. Tel: Sloane 6178.

British Patent No. 742210

235

STEEL FRAME BUILDINGS
OF EVERY DESCRIPTION

Factories, Sheds, Mill Buildings, Bungalows, Etc. Etc.,

SPECIALITIES: Pit Headgear, Pumping Stations, Power Stations

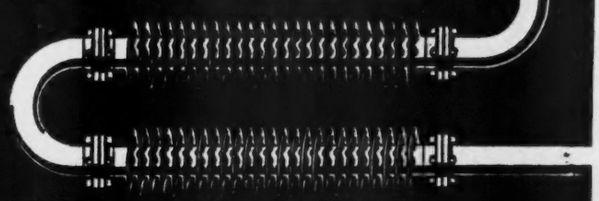
Bridgework and Riveted Work of all descriptions

BROWNLIE & MURRAY LTD.
POSSIL IRONWORKS, POSSIL PARK, GLASGOW
LONDON: 32 QUEEN VICTORIA ST., E.C.4

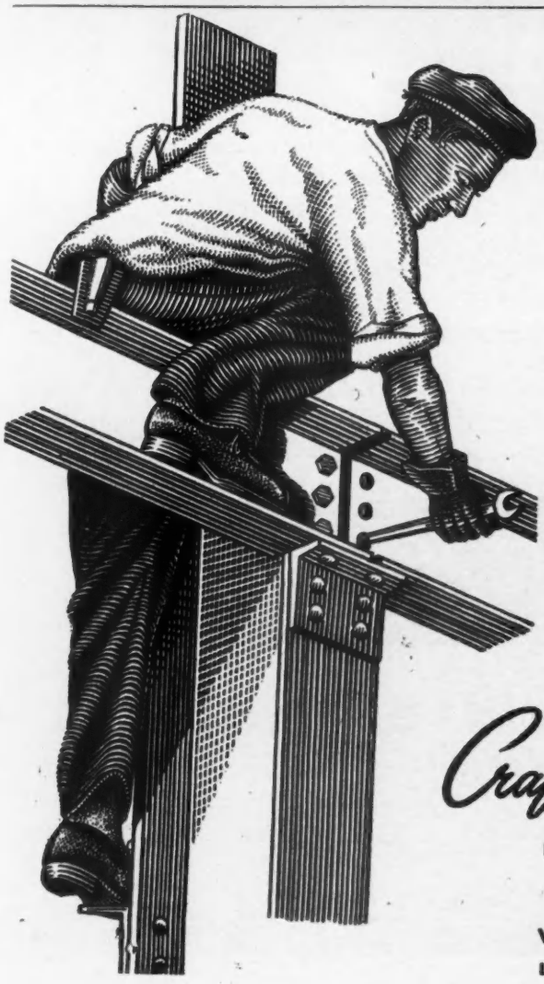
LONG LIFE L.F.5 FLOAT TYPE STEAM TRAP
The Long Life Trap has been designed to meet the requirements of many of our customers who desire a trap of the calibre of the 1912 Float Type (many of which have worked for 40-50 years and still working) for present day needs.
MADE IN THE FOLLOWING SIZES : ½" or ¾", 1" or 1¼", 1½" or 2" and suitable for all PRESSURES UP TO 180 lbs. per sq. in.
CANNOT BECOME AIRLOCKED—WILL LIFT ITS DISCHARGE—CAN BE EXAMINED WHILE WORKING. THE MOST ECONOMICAL, EFFICIENT AND SAFEST TRAP ON THE MARKET. THE TRAP WITH THE FRICTIONLESS LOOSE DISC VALVE.

LANCASTER & TONGE LTD
PENDLETON · MANCHESTER · ENGLAND
Telephone: Pendleton 1484/5/6
Telegrams: "Pistons, Manchester"

HUNT



Gilled Tubes & Heaters
HUNT & MOSCROP LIMITED
P. O. Box No. 8 MIDDLETON · MANCHESTER



Craftsmanship comes the hard way...

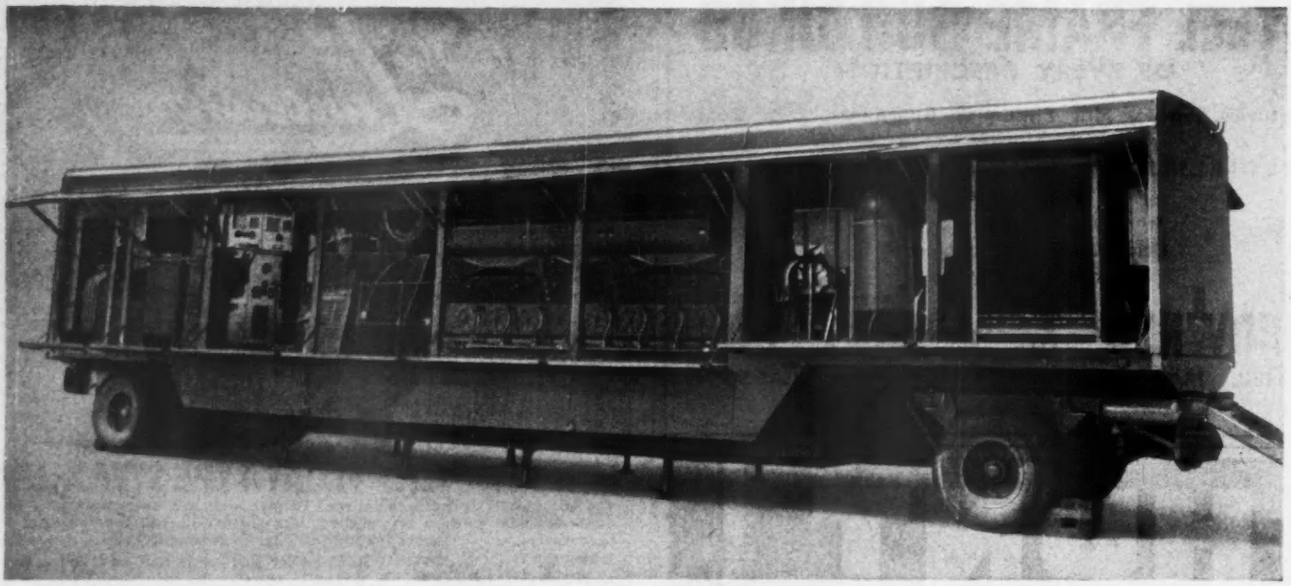
If over 90 years spent in the design, fabrication and erection of structural steelwork means anything—it means you can place this work in our hands knowing it will progress smoothly to completion. Large job or small, we have the resources to handle all your needs. We welcome the opportunity of serving you.

Craftsmen in steel..

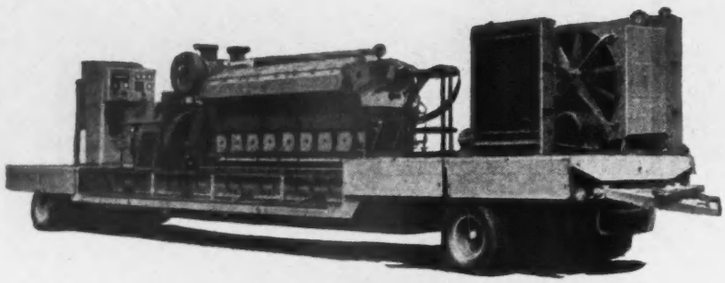
WALKER BROS LIMITED *Structural Engineers*

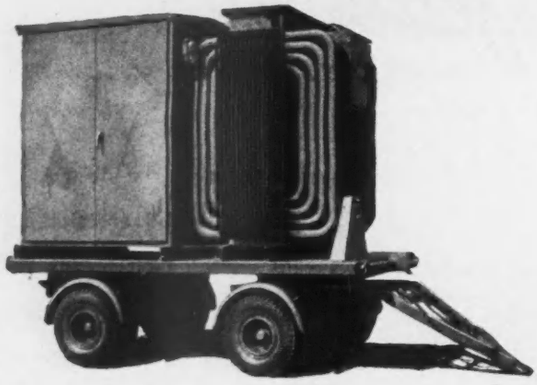
ESTABLISHED 1847

WALKER BROS. LTD. WALSALL, STAFFS Telephone: WALSALL 3136
LONDON OFFICE: 66, VICTORIA STREET, S.W.1 Telephone: VICtoria 3926



Mobile Power for Venezuela





Four of the largest mobile generating sets ever constructed have recently been completed by Mirrlees, Bickerton & Day Ltd. for La Corporacion Venezolana de Fomento. Designed for use in townships and works where the local permanent power station is not sufficient to meet the demand, these diesel generators are capable of providing power for an average town.

The sets are made up of two trailers; one for generation the other for transformer duties. The power unit consists basically of a Mirrlees JVS.16 turbo-charged diesel engine with a continuous site rating at 900 r.p.m. of 1727 b.h p. This drives a Brush 1200 kW generator, installed complete with switchgear and control panel.

The other trailer carries a Brush 1500 kVA Transformer which is capable of converting the full alternator output from 2,400 to 13,800 volts.

Mirrlees diesel power once again leads the way.

* **The photographs show :—**

TOP: *Complete Generation Trailer. Weight approx. 52 tons, 50 ft. long, 10 ft. wide, 12 ft. high.*

CENTRE: *Mirrlees JVS.16 diesel engine and Brush generator in process of being fitted on Generation Trailer.*

BOTTOM: *Transformer Trailer. Weight approx. 10 tons. 12 ft. 6 ins. long, 7 ft. 6 ins. wide, 12 ft. high.*

Mirrlees

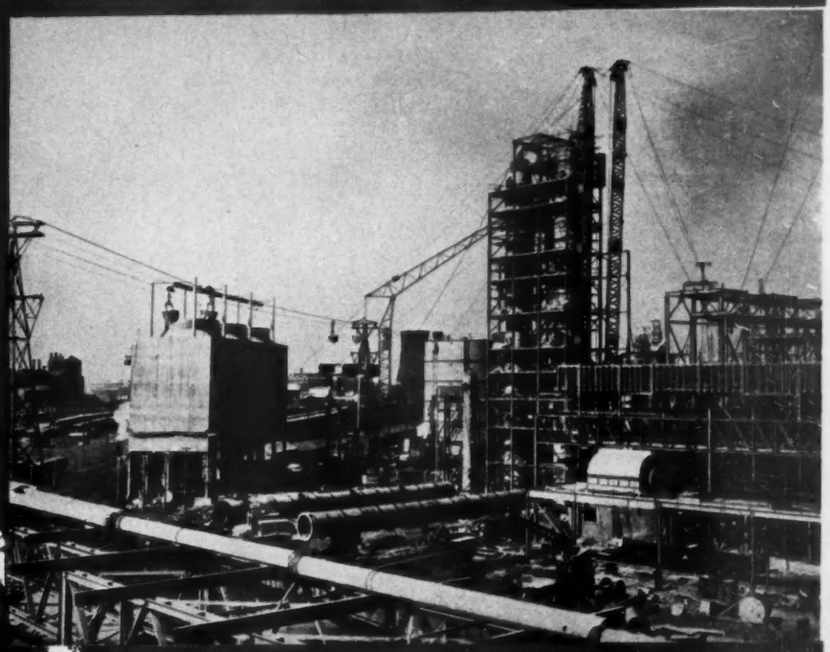
diesels

MIRRLEES, BICKERTON AND DAY LIMITED · HAZEL GROVE · STOCKPORT · CHESHIRE

Telephone : Stepping Hill 1000 *A member of the Hawker Siddeley Group* *Telegrams :* " Mirrlees, Telex, Manchester "

IE24

Comprehensive Engineering Services



PROCESS PLANT PIPEWORK INSTALLATIONS MECHANICAL EQUIPMENT RADIOGRAPHIC SERVICES

ABP

ASSOCIATED WITH THE POWER-GAS CORPORATION LIMITED
STOCKTON-ON-TEES AND LONDON

390 AUSTRALIA · CANADA · INDIA · FRANCE · SOUTH AFRICA

The latest techniques in the rolling mill . . .

. . . demand the latest techniques in roll making

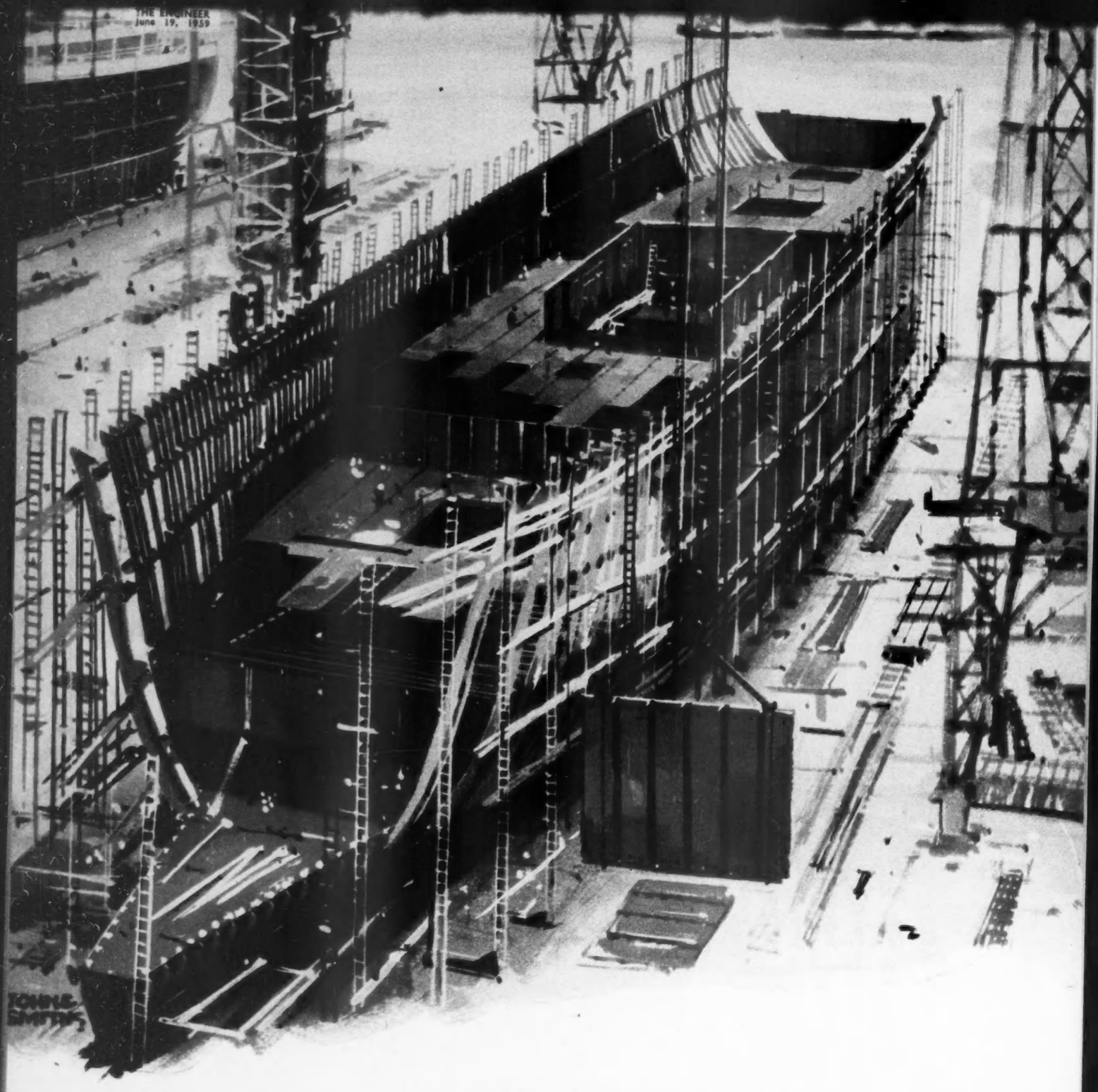
by

FIRTH BROWN

ALLOY STEELMAKERS FORGEMASTERS
STEEL FOUNDERS · HEAVY ENGINEERS

THOS FIRTH & JOHN BROWN LIMITED · SHEFFIELD · ENGLAND

SDF
SMETHWICK DROP FORGINGS
MASTERS OF THEIR TRADE
SMETHWICK DROP FORGINGS LTD · SMETHWICK & KIDDERMINSTER



IN SHIPYARDS, as in every sphere of industry, Metropolitan-Vickers are in the forefront of electrical progress. Many advances in the design of motors and welding machines for shipyards owe their origin to the research, enterprise and experience of this great organization.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER 17

An A.E.I. Company

LEADING ELECTRICAL PROGRESS

A/A81

Sanding drum casting drilled by eight Par-A-Matics simultaneously. Precision mounting clamps ensure accurate set-up. Note variety of angular mounting positions.

"ARO-BROOMWADE" PAR-A-MATICS

Save Man - hours

Par-A-Matics are compact, self-feed pneumatic tools designed for multiple drilling, burring, tapping, grinding, reaming, nut-running, positioning . . . almost any operation requiring rotating tools which can be accommodated in a $\frac{1}{4}$" or $\frac{5}{16}$" chuck.

QUICKLY ADAPTED TO CHANGING NEEDS

Par-A-Matics are invaluable for long or short production runs. Gears are interchangeable for speedy conversion to any of seven speeds from 500 to 17,000 r.p.m. You can easily mount Par-A-Matics at any angle for automatic or semi-automatic operation. You can link any number for simultaneous functioning. One man, using a remote control valve, can operate a whole battery of Par-A-Matics.

Par-A-Matics really *will* SAVE YOU MONEY. Expert technical advisers are available for guidance on schematic layouts, based on a wide experience in the application of Par-A-Matics. Ask for Publication No. 443 T.E.

"BROOMWADE"

Air Compressors & Pneumatic Tools

YOUR BEST INVESTMENT

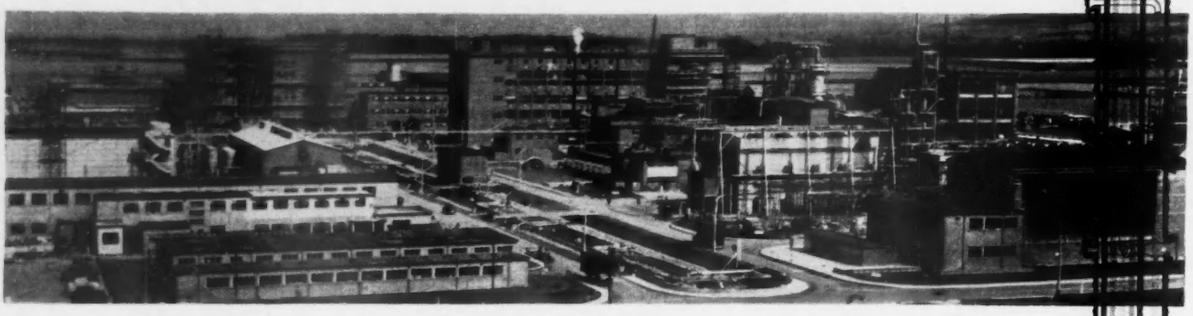
BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND

Telephone: High Wycombe 1630 (10 lines) Telegrams: "Broom", High Wycombe. (Telex.) 603A. SAS

THE VERSATILITY OF PAR - A - MATICS covers almost any kind of rotating tool

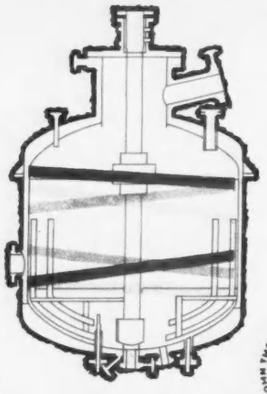
D

chemical plant fabrication



John Thompson (Dudley), Ltd., fabricate plant for all industrial chemical processes in mild steel and special materials such as stainless steel, Monel, nickel, Inconel and clad and non-ferrous metals. Complete constructions (including large fusion welded pressure vessels by John Thompson, Wolverhampton) and installation are undertaken, with pipework, chimneys and supporting steelwork, etc.

The photograph is by courtesy of Imperial Chemical Industries Ltd., Wilton, and the accompanying diagrams are of stainless steel vessels used in chemical processes in the production of " Terylene " polymer, which material is subsequently spun into fibre and yarn.

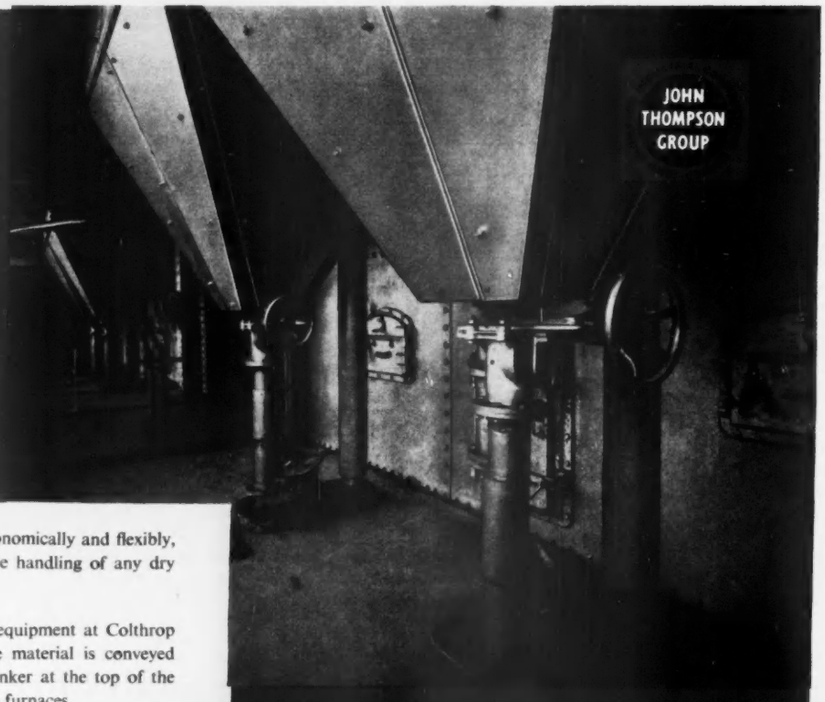


JOHN THOMPSON (DUDLEY) LIMITED JOHN THOMPSON GROUP

JOHN THOMPSON (DUDLEY) LTD · DUDLEY · WORCS.,

DC/4A

FOR HANDLING PULVERISED OR GRANULAR MATERIALS



Pneumatic Handling can be applied economically and flexibly, even in smaller industrial plants, to the handling of any dry pulverised or granular materials.

In the illustration of John Thompson equipment at Colthrop Board and Paper Mills, Newbury, the material is conveyed from the four storage hoppers to a bunker at the top of the building, so that it can be re-fired to the furnaces.

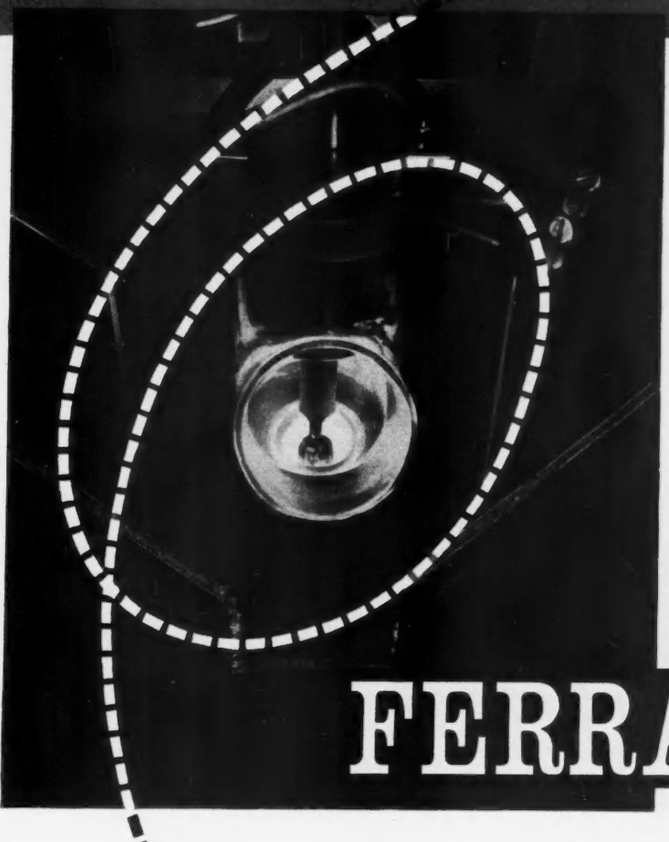
Note the four material loading valves fitted directly to the storage hoppers ; from these the conveying pipeline runs to a lower level for interconnection before rising to the container at the top of the building.

JOHN

2 PRINCES ROW, BUCKINGHAM PALACE RD., S W 1.

ICR/4

The heart of the matter... the art of the matter



The formation of a single silicon crystal ingot

FERRANTI

offer the widest range of

SILICON Semiconductor Devices

in the United Kingdom

Ferranti Ltd. were the first company in Britain to introduce Silicon semiconductor devices as used in magnetic amplifiers, in aircraft, guided missiles, radar and computers. Until recently they were the only firm in the United Kingdom supplying silicon diodes in quantity. Commencing their programme of research and development in 1954, they have already made outstanding contributions to technique, and are now producing at Gem Mill, Oldham well over half-a-million silicon diodes annually in the widest range offered by any British manufacturer.

Among the 120 or more different devices are rectifiers, fast diodes, zener diodes, tetra-layer diodes and triodes, alloy junction transistors, diffused junction transistors, photo-voltaic cells, voltage variable capacitors and many new ones.

Data Sheets, Application Reports etc., advice and assistance in techniques of application are freely available.

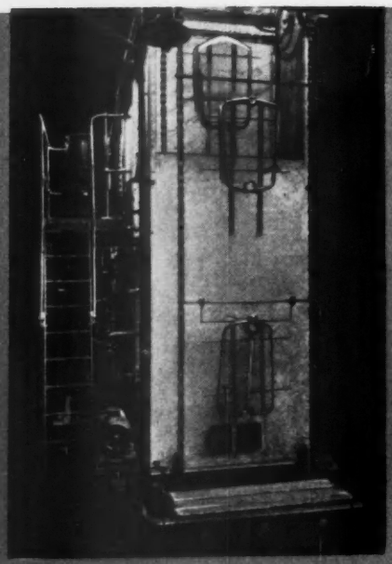
FERRANTI

SILICON SEMICONDUCTOR DEVICES

FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS · [illegible]

[illegible] HOUSE · [illegible] · W.C.2 [illegible]

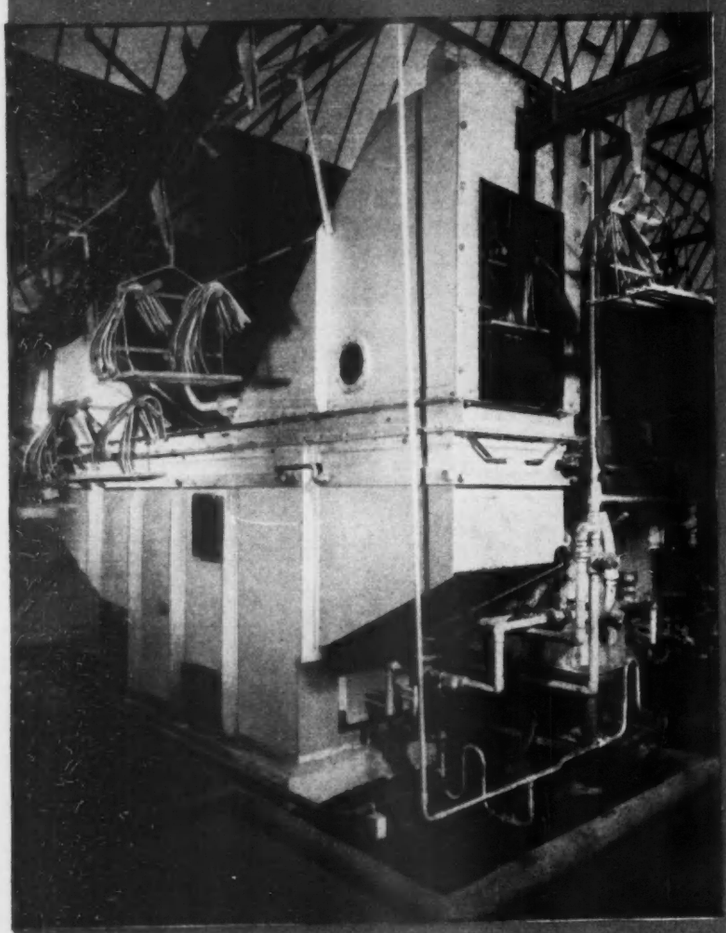
FE 190/2



1933

Morris Motors Ltd. installed one of the first-ever continuous I.C.I. metal degreasing plants. This was arranged for degreasing radiator shells, hub caps, etc. after polishing, and provided liquor, vapour and jetting treatment with trichloroethylene. After 24 years this plant continues to give excellent service, degreasing approximately 30,000 assorted articles per week.

One good plant sells another



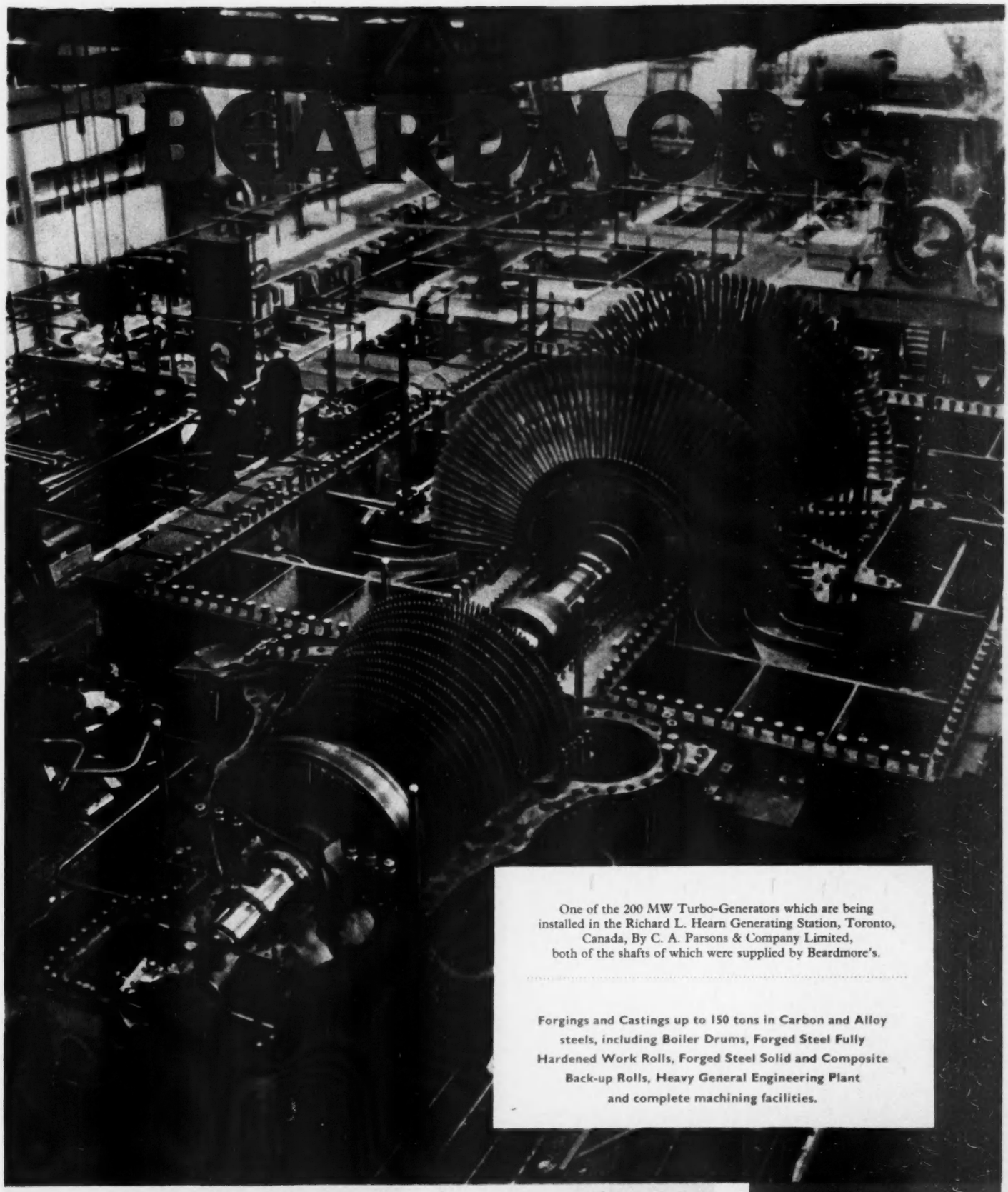
1956

After many years' practical experience in the design and construction of continuous plants, I.C.I. supplied a second plant fitted with a monorail conveyor to link up with the Firm's production line, and arranged for boiling liquor treatment to remove polishing compound from motor car windscreen and window frames. After leaving the plant, stainless steel parts are packed for despatch while those in brass and mild steel pass to the painting shop.

◀ *The new plant in service.*

For advice on metal degreasing problems, consult

IMPERIAL CHEMICAL INDUSTRIES LTD., ICI LONDON, S.W.1

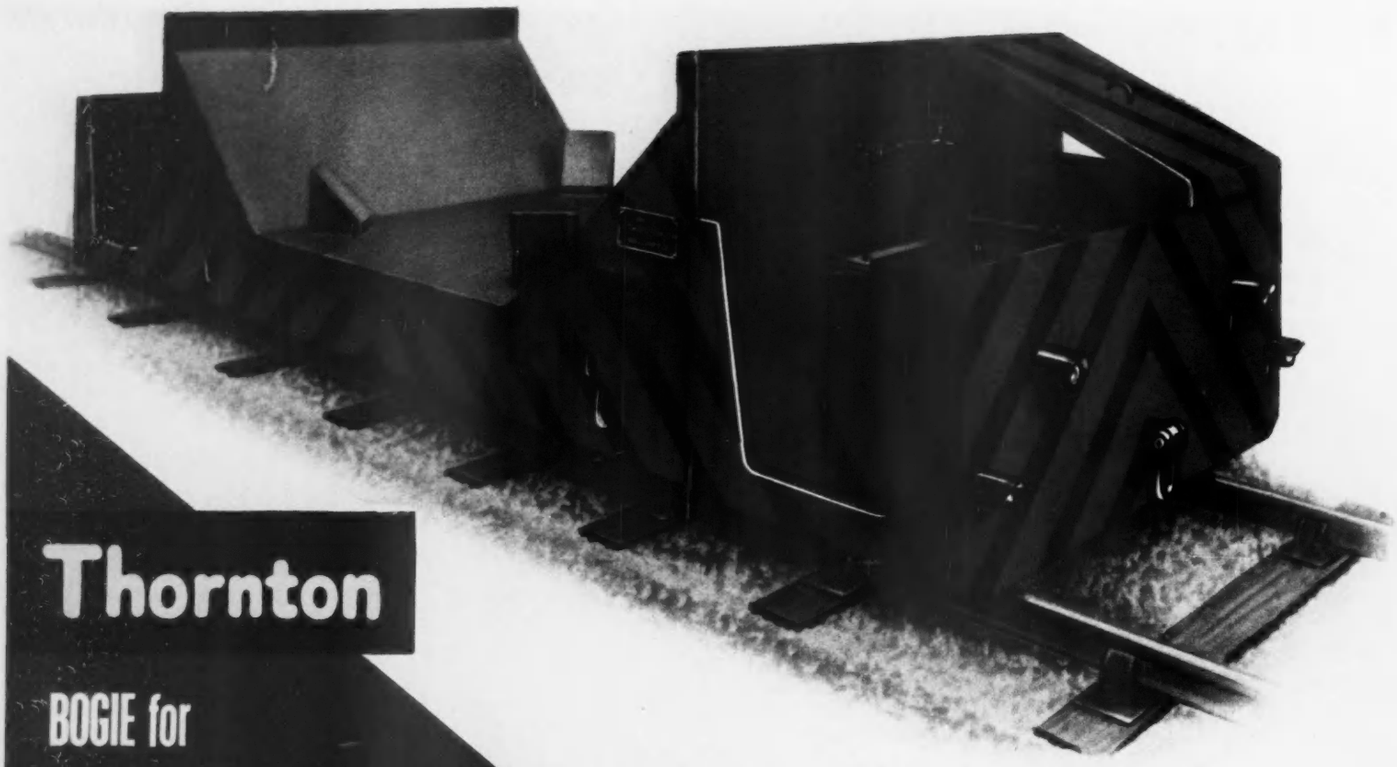


One of the 200 MW Turbo-Generators which are being installed in the Richard L. Hearn Generating Station, Toronto, Canada, By C. A. Parsons & Company Limited, both of the shafts of which were supplied by Beardmore's.

Forgings and Castings up to 150 tons in Carbon and Alloy steels, including Boiler Drums, Forged Steel Fully Hardened Work Rolls, Forged Steel Solid and Composite Back-up Rolls, Heavy General Engineering Plant and complete machining facilities.

WILLIAM BEARDMORE & CO LIMITED

Parkhead Steel Works, Glasgow, E.1. Telephone: BRidgeton 1881-8 Telegrams: Beardmore, Glasgow



Thornton

BOGIE for 30 ton Capacity Electric Furnace Charging Basket

transport a 30 ton capacity Electric
ng Basket. Total weight of Basket and contents 43 tons. Frame fabricated
nd arranged with Controls, Handbrake, Battery, Headlights and Rear Lights
with Electric Hooter for continuous sounding immediately power is applied.
and powered by two 15 H.P. Motors direct coupled to axles through totally
d Worm Reduction Units. Speed of Car 3.1 m.p.h. Wheels arranged for 4′ 8½″ rail
ge and axles rotate in Roller Bearing Axle Boxes. Constructed and painted to comply
with Safety Regulations in Steel Works.

CONSULT US . . .

for the design and manufacture of medium and heavy engineering equipment for all steel works plant including Rolling Mills and their auxiliaries, all types of Ingot and Transfer Cars, Gas Works and Chemical Plant, Heavy fabrications and Pressure Vessels.

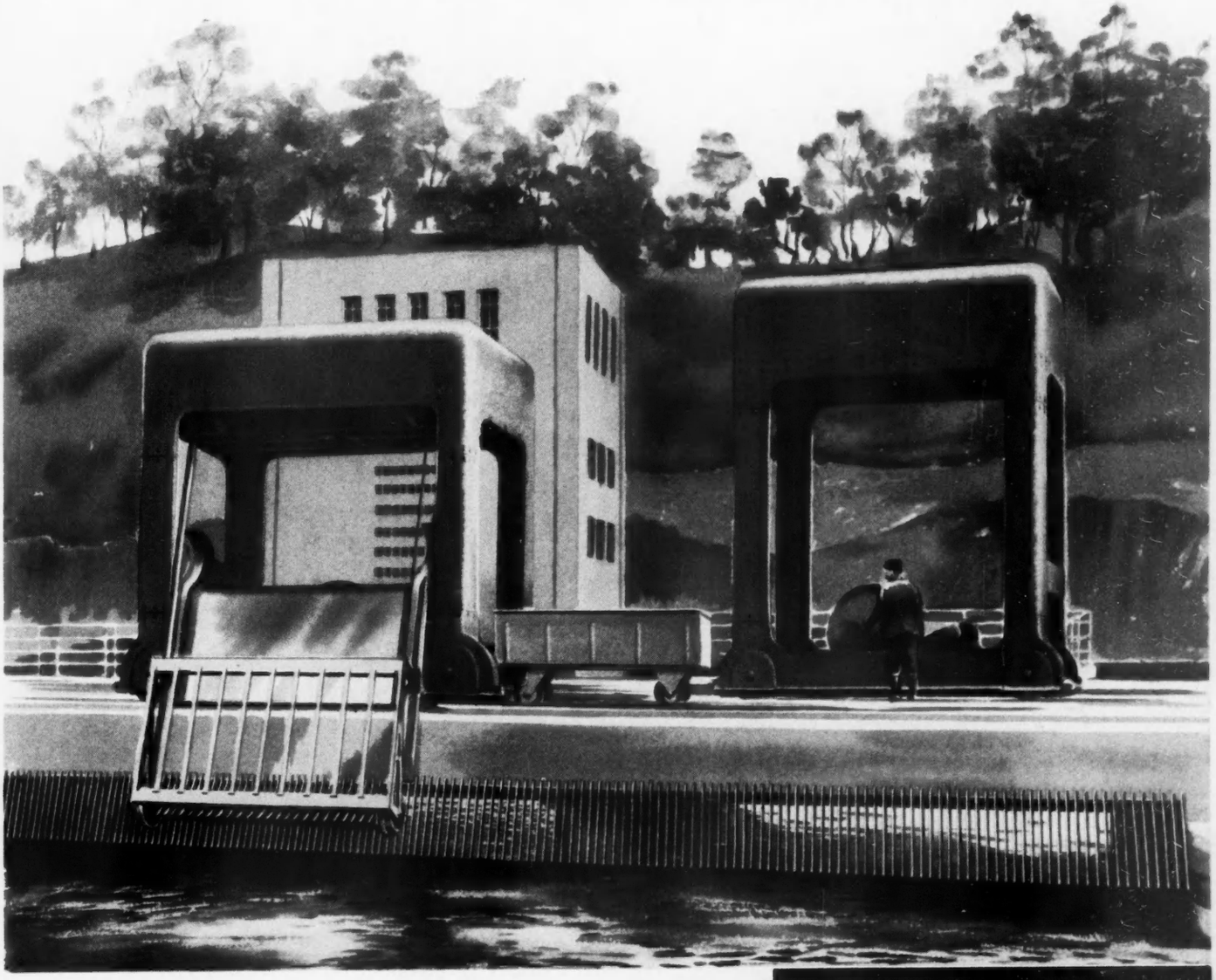
B. THORNTON LTD.

TURNBRIDGE HUDDERSFIELD

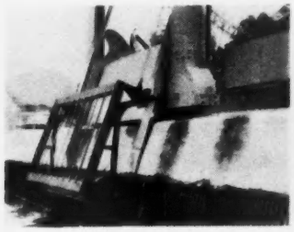
Phone: Huddersfield 7541

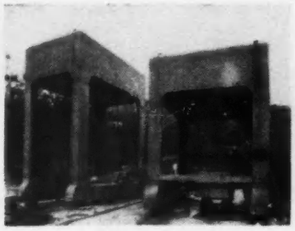
All types of

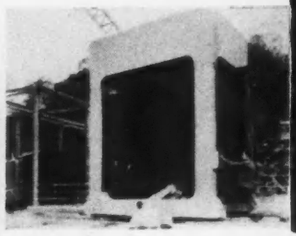
mechanical handling plant



. . . screens, trash rakes and cranes for hydro-electric intake works . . .







Strachan and Henshaw Ltd

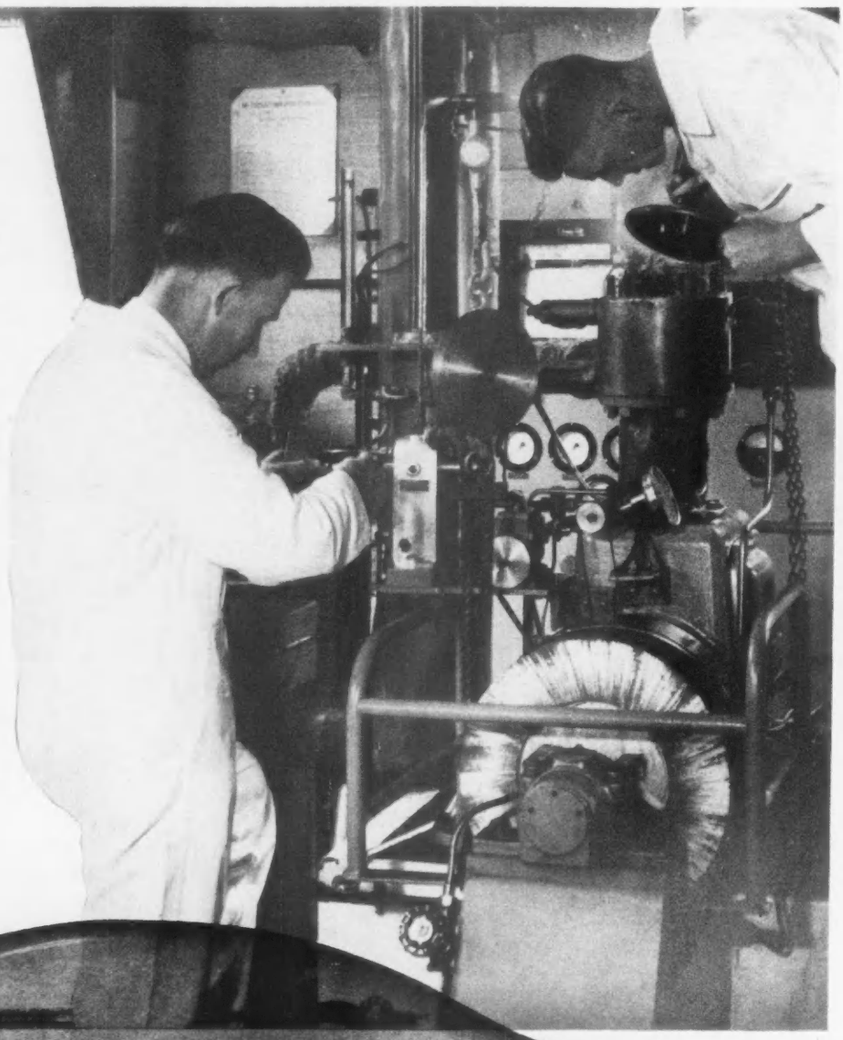
STEELHOIST WORKS
BRISTOL 2 ENGLAND

TELEPHONE BRISTOL 78331

Quality control

for better protection is . . .

smoothing the way to higher production



Dismantling a lubricants test engine for examination at the BP Research Station

BP

ENERGOL

LUBRICANTS

PRODUCTS OF THE BRITISH PETROLEUM COMPANY LTD

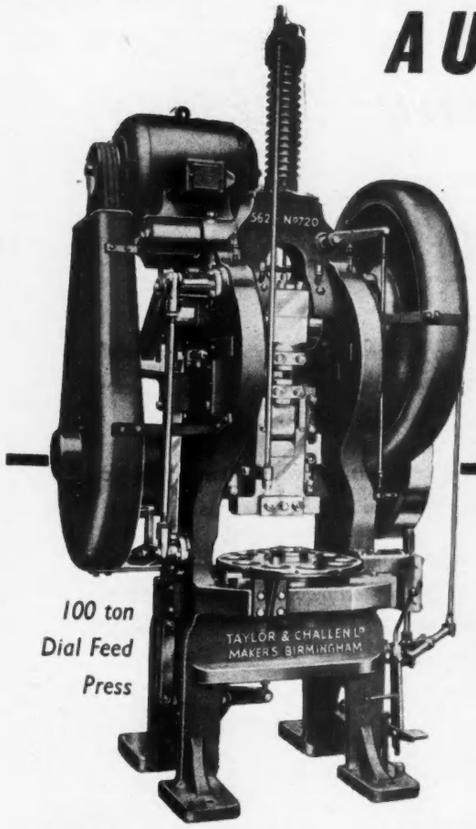
Distributors

THE POWER PETROLEUM CO. LTD.

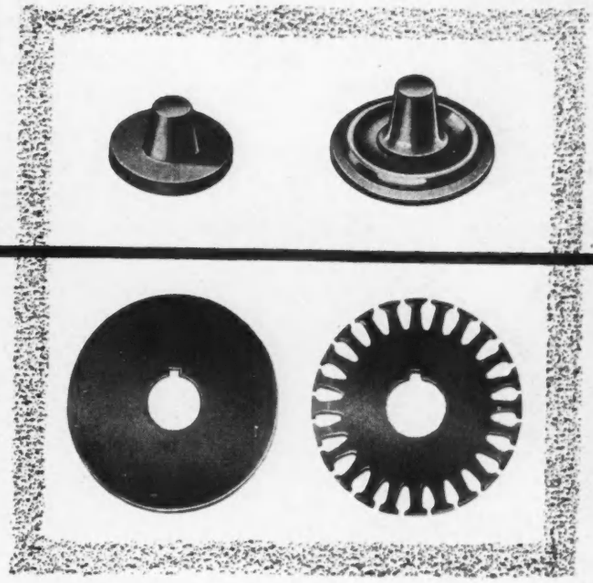
Head Office: 76/86 STRAND · LONDON W.C.2 *(Branches and Depots throughout the country)*

Our Technical Department will be pleased to advise on your lubrication requirements and problems

AUTOMATIC FEED PRESSES



100 ton Dial Feed Press



WE ALSO MAKE

- Power Screw Presses
- Double Action type Drawing Presses
- Single and Double Crank Presses
- Open-fronted Presses
- Double sided Presses
- Cartridge machinery
- Minting machinery

MEMBER

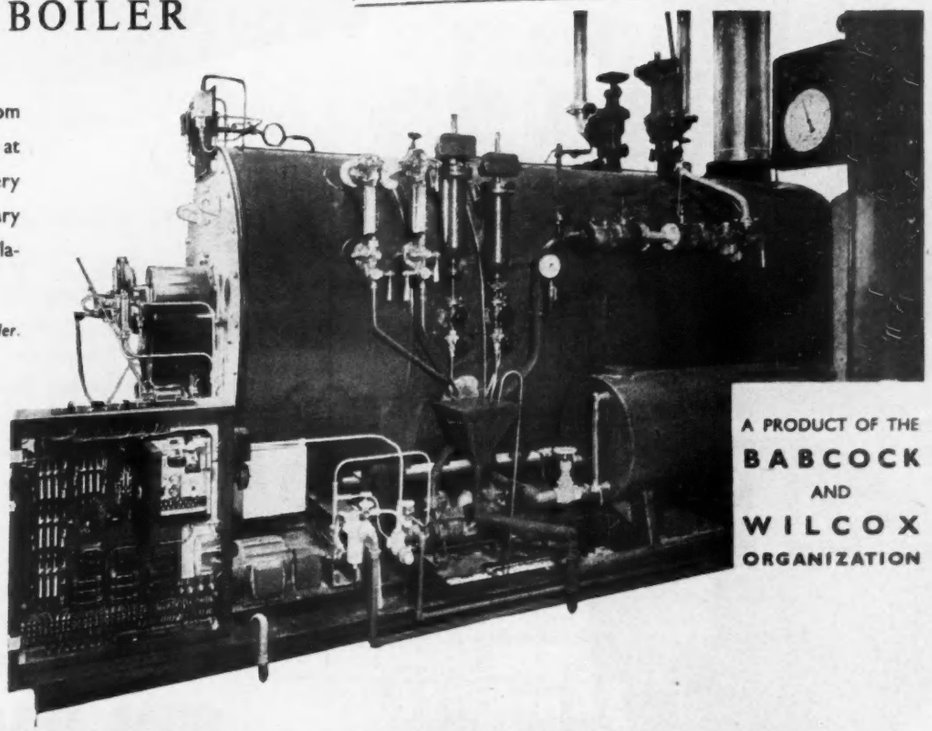
TAYLOR & CHALLEN LTD. BIRMINGHAM 19

"THE STEAMBLOC" PACKAGED BOILER

Fully Automatic—Oil Fired High Efficiency Boiler Plant GUARANTEED 82.5% EFFICIENCY

The Steambloc is designed in a range from 1,500 to 18,000 lb. steam per hour (from and at 212°F). Its special three-pass design enables very high efficiencies to be obtained under ordinary commercial operating conditions. On many installations it exceeds 85%.

Send for Publication No. 1628/3—The Steambloc Packaged Boiler.

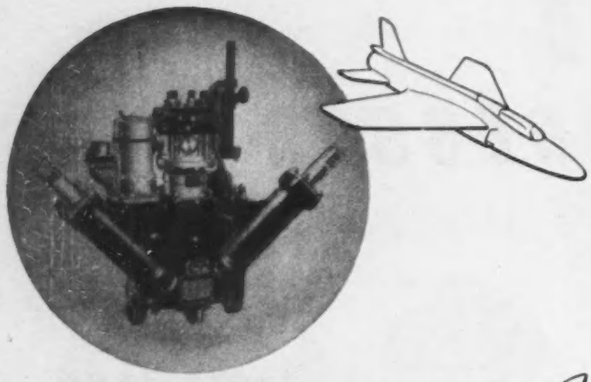


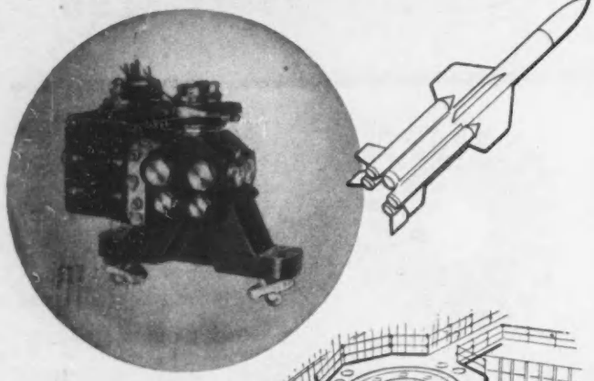
A PRODUCT OF THE BABCOCK AND WILCOX ORGANIZATION

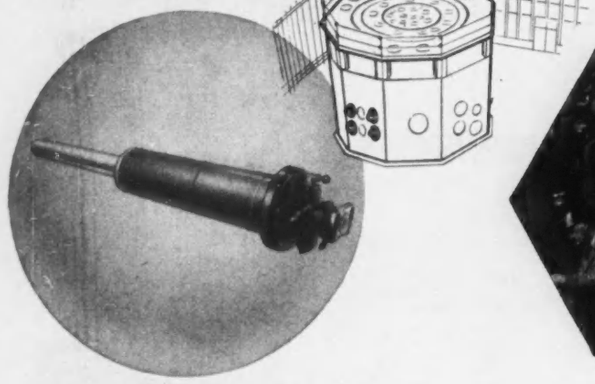
Lower steam requirements are met by the CLARKSON Packaged Vertical Boiler of Thimble Tube Design. Range 250 lb. up to 3000 lb. steam per hr. Max. W.P. 120—Clarkson Thimble Tube Boilers. Send for Publication No. 702.

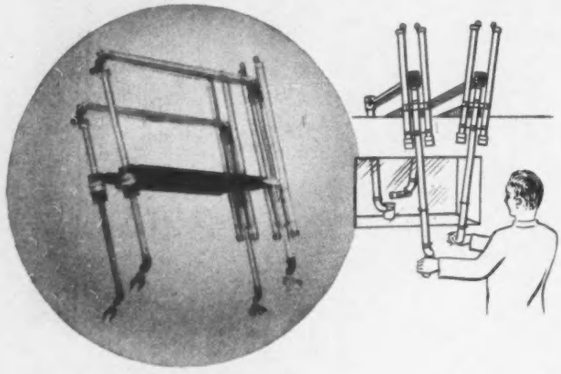
SPENCER - BONECOURT - CLARKSON LTD.

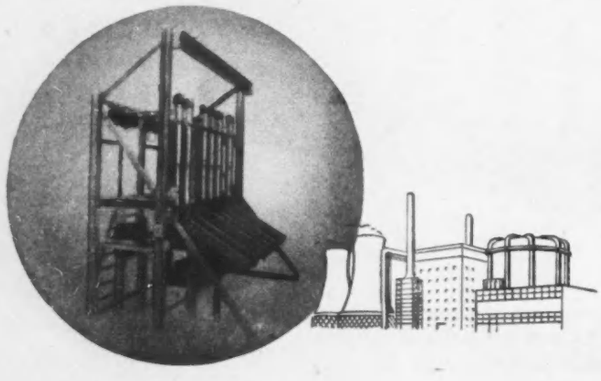
28 Easton Street, London, W.C.1. Telephone: Terminus 7466











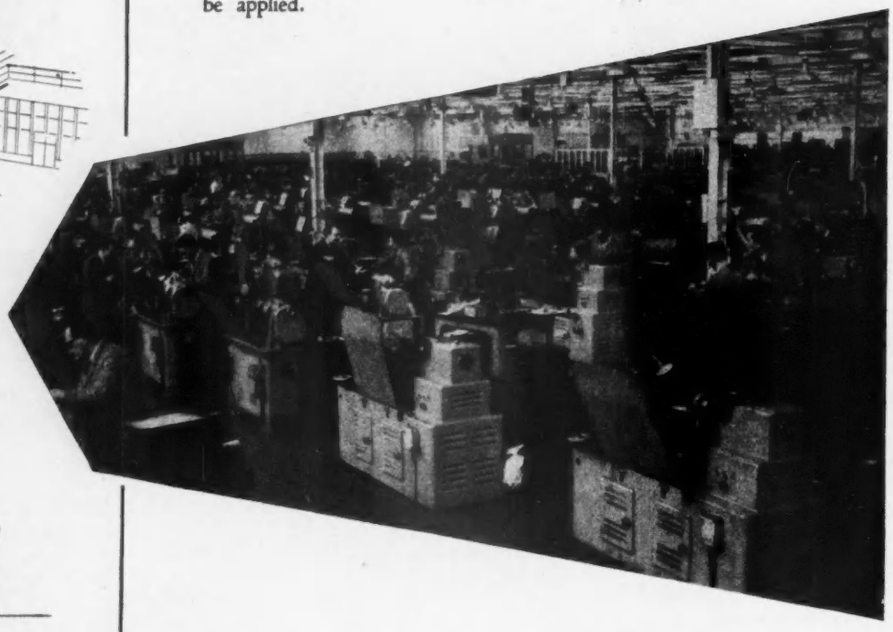
In Many Spheres...

Hobson

Skill and experience in engineering has long been successfully applied in the design, development and manufacture of various specialised components of high precision character.

Present production is concerned mainly with advanced projects relative to the aircraft and nuclear power industries.

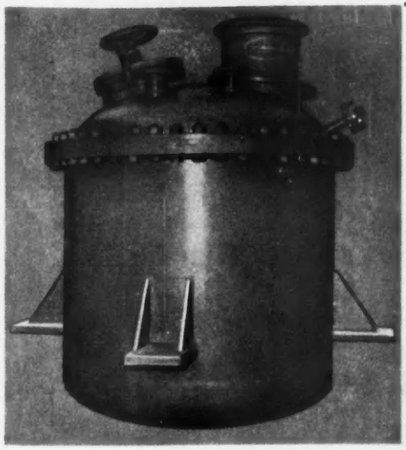
We have a technical staff capable of dealing with the many problems of modern engineering technique and invite enquiries regarding projects to which our wide experience can usefully be applied.



TYPICAL EXAMPLES OF HOBSON PRODUCTS

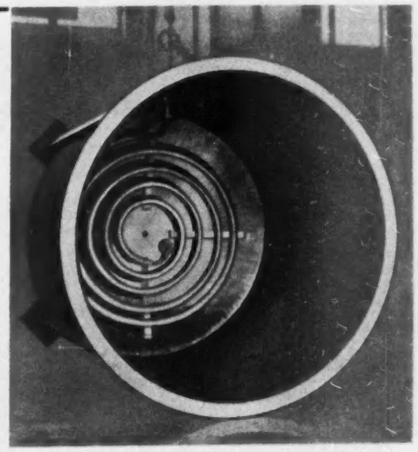
Hydraulic Jacks and Servos
Electro-Hydraulic Servo Actuators
Hydraulic Pumps and Motors
Liquid Flowmeters
Engine Control Systems
Mercury Manometers
Remote Reading Contents Gauges
Remote Handling Equipment
Honeycomb Isotope Manufacturing Machines
Electro-Mechanical Control Systems for Atomic Reactors
Specialised Gearboxes
Atomic Reactor Ancillary Equipment
Hydraulic Variable Speed Drives

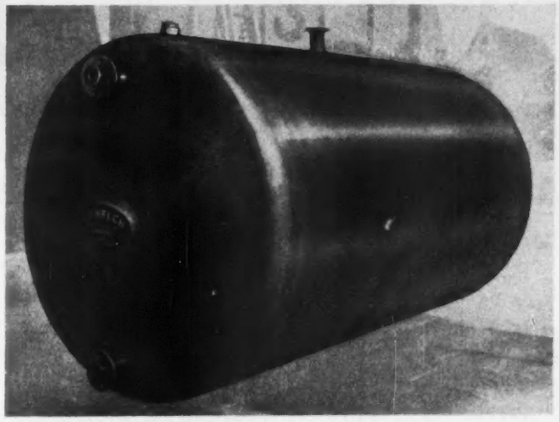
H. M. HOBSON LIMITED
WOLVERHAMPTON ENGLAND



CHEMICAL PLANT & EQUIPMENT

COPPER
ALUMINIUM
STAINLESS STEEL
MILD STEEL





PLANT to Specification

CONDENSERS
DISTILLATION UNITS
REACTORS Etc.

PRESSURE VESSELS
OF ALL KINDS

DELIVERIES PROMPT
PRICES COMPETITIVE

CRAFTSMANSHIP IN
ALL METALS

J. A. WELCH (PLANT & VESSEL) LTD.

STALCO WORKS, LIVINGSTONE RD., LONDON, E.15

TELEPHONE : MARYLAND 5818 (3 lines).

NOTHING GETS PAST Hallprene

Hallprene

PATENT FLUID SEALS

PATENT No. 734525
U.S.A. PATENT No. 2,755,118
CANADIAN PATENT No. 547268

High pressure sealing over long periods is ensured by Hallprene Patent Fluid Seals. These seals overcome certain disadvantages of normal "U" type packing rings. Handling damage and inward collapse of the sealing lips is prevented by a soft, pliable synthetic rubber filling. Under pressure, this filling forces out the walls, ensuring a perfect seal.

Hallprene Patent Fluid seals are impervious to the action of hydraulic fluids.

HALL & HALL LTD

OLDFIELD WORKS HAMPTON MIDDLESEX . Tel: Molesey 2180 (8 lines)

IN SCOTLAND:—
WILSON PLACE EAST KILBRIDE GLASGOW · Telephone: East Kilbride 20581

P329

OVERHEAD · TRAVELLERS · ELECTRIC GOLIATH

LOCOSTEAM

MARSHALL FLEMING CRANES

BEST 1919

OVER HEAD

DELLBURN WORKS MOTHERWELL·SCOTLAND
Telephone: Motherwell 58 Telegrams: "Dellburn" Motherwell

LOCO STEAM · ELECTRIC GOLIATH · TRAVELLER

The Nitriding Process for Case-hardening Special Steels by Nitrogen offers

- **Surface hardness up to 1100 D.P.H.**
- **Retention of full hardness after heating to 500°C.**
- **Maximum resistance to frictional wear and fatigue.**
- **Improved resistance to corrosion by water and steam.**

Particulars from:—

NITRALLOY LIMITED

ATLAS WORKS SHEFFIELD, 4.

Telephone: Sheffield 26646. Telegrams: "NITRALLOY, SHEFFIELD."

SUPREX
OILY
WATER
SEPARATORS

Proven the most efficient

Officially approved by the Ministry of Transport

J. H. CARRUTHERS
& CO. LTD.
HAMILTON STREET · GLASGOW S2 · SCOTLAND

FLOORING SPECIALISTS
FOR 100 YEARS

'IMMOVABLE-ACME' HARDWOOD FLOORS
ACME PAVING FOR FACTORY FLOORS
'ACMETYLE' SUPER P.V.C.
'FIRMOSEC' LINOLEUM
CORK TILES
FITTED CARPETS
RUBBER FLOORING

TECHNICAL BROCHURE ON REQUEST

We specialise
in all flooring renovations

ACME FLOORING & PAVING
CO (1904) LTD

RIVER ROAD, BARKING, ESSEX. Rippleway 2771 (7 lines)

A NEW CATALOGUE

This Comprehensive Catalogue, published by the Pioneers of Industrial First Aid, includes a section summarising British First Aid Regulations. It is available free to purchasers of First Aid equipment *who apply on their Company's letterhead, and refer to this Journal.*

CUXSON, GERRARD & Co Ltd
OLDBURY, BIRMINGHAM
ESTABLISHED 1878
Phone: BROadwell 1355

Clever... isn't it?

A trick of this sort is certainly worthy of the best circus performer. But although we do not claim any connections with a circus, there is a clever act performed all day by the Chatwin Polygon Tool Box.

This lathe attachment will turn hexagons, octagons, squares or other shapes from round bar in one operation. If you agree that this is a trick worth knowing, why not write to us for a copy of the booklet on the Chatwin Polygon Tool Box.

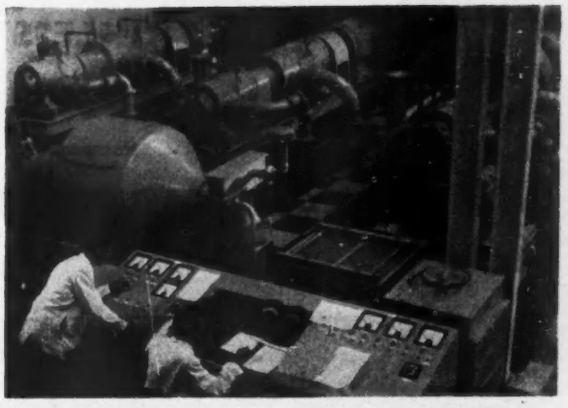
THOMAS CHATWIN & CO.

GT. TINDAL STREET, BIRMINGHAM 16. Phone: Edgbaston 3521
London Office: 25 Hanover Square, W.1. 'Phone MAYfair 8783
Area Sales Offices in Newcastle Upon Tyne, Bristol & Manchester

ONE OF THE BROCKHOUSE COMPANIES

HOLLAND / SLM ROTARY COMPRESSORS AND VACUUM PUMPS

GIVE SERVICE FOR TO-DAY, FOR TO-MORROW AND FOR YEARS AHEAD



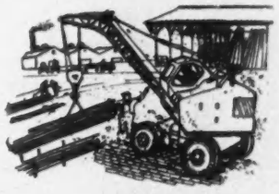
Part of the English Electric Aircraft Equipment Laboratories with three HOLLAND/SLM 2-stage rotary vacuum pumps exhausting the altitude test chamber.

The B. A. Holland Engineering Co. Ltd.

LINDO LODGE, STANLEY AVENUE, CHESHAM, BUCKS.

Telephone: 8406/8. Works: SLOUGH, BUCKS. Telegrams: Picturable, Chesham.

POWER for industry



Our range of industrial engines are a practical proposition for many types of industrial equipment . . . **compressors, cranes, pumps, contracting equipment, earth borers, generators, railcars, welding plant, works trucks, tractors and conversions.** Simple design, modern flow-line production methods and common interchangeable parts contribute to the low cost of these high efficiency engines. And remember, every engine is fully backed by a World-wide Parts and Service Organisation. Take your choice from a wide power range . . . Diesel 20 to 86 b.h.p. and Petrol 11 to 87 b.h.p. (12-hr. rating).

DIESEL ECONOMY—have you considered the replacement of existing power units in your equipment and trucks with the famous 4D Diesel engine? You'll have the unique advantages of economy, long-life and low running costs . . . plus the best service in the World!

Wherever you are, whatever your problem,

FORD

MOTOR COMPANY LIMITED ENGLAND

are at your service

For further details of our

INDUSTRIAL ENGINES

and the equipment they power, send the coupon to your nearest Ford Dealer or direct to

Please send me technical brochures of your *PETROL/DIESEL Industrial Engines. The maximum B.H.P. required is ..... at ..... R.P.M. Also, please send details of the following equipment powered by your engines.

.....

.....

Name .....

Address .....

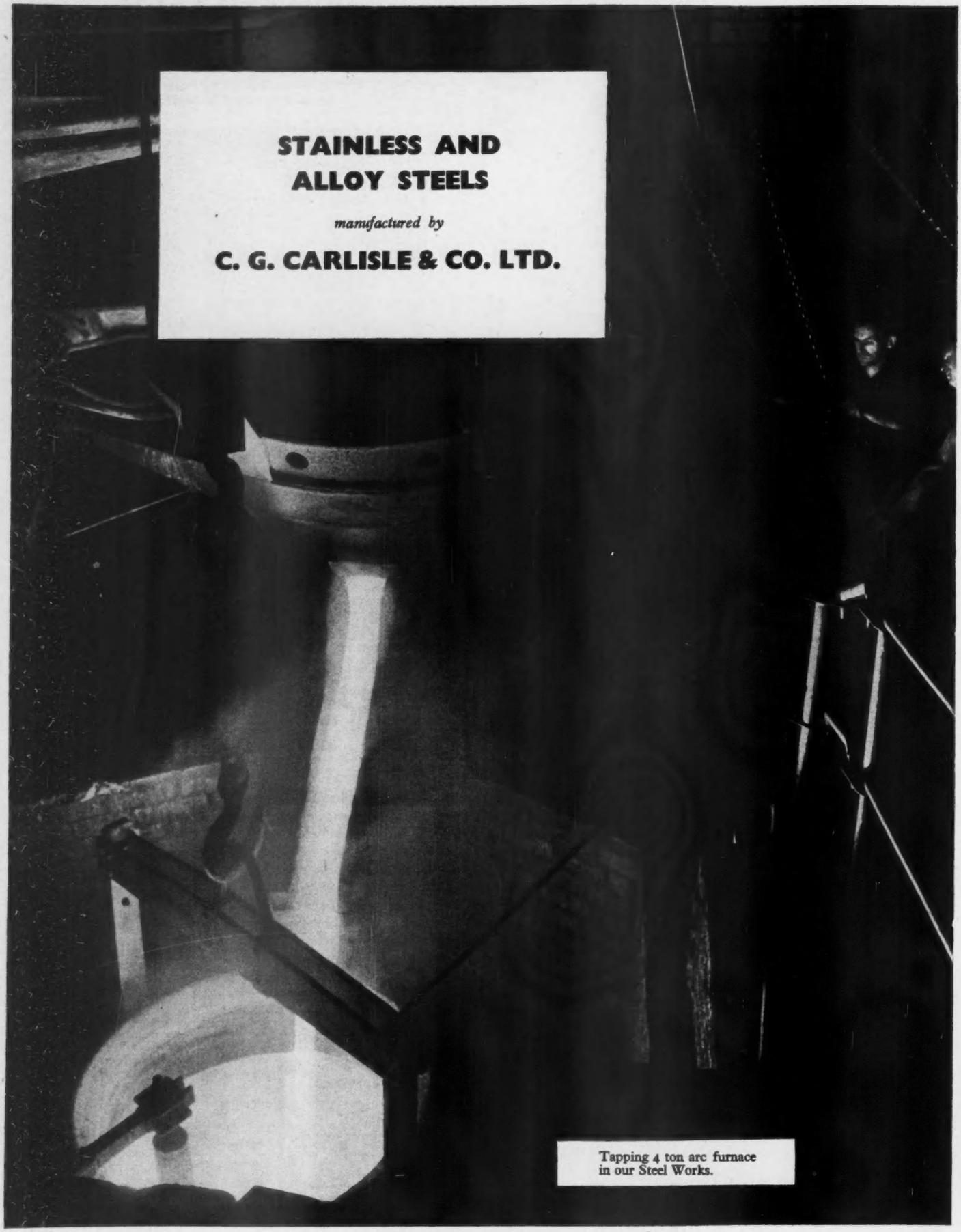
.....

Nature of Business .....

Telephone No. .....

** Delete where not applicable* G51·22·6

FORD MOTOR COMPANY LTD · PARTS DIVISION (G51) · AVELEY DEPOT · SOUTH OCKENDON · ROMFORD · ESSEX · ENGLAND



C. G. CARLISLE & CO. LTD. IONA STEELWORKS. PENISTONE ROAD. SHEFFIELD 6

Telephone: SHEFFIELD 348791/2/3. Telegrams: 'NICHROME' SHEFFIELD.

Industrial plant

. . . of all kinds

All manner of static plant and equipment is covered by Wards' INDUSTRIAL PLANT DEPARTMENT —Boilers (from smallest portable to largest of water-tube and marine types), Tanks of all types (including Braithwaite sectional steel tanks), Jacketed Pans, Chemical Plant, Steel and Aluminium Alloy Scaffolding, Autoclaves, Air Receivers, Pipes and Tubing, Valves and Fittings, Boiler House Accessories, etc. Write for further particulars.

INDUSTRIAL PLANT DEPARTMENT,
THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.
Tel: 26311 (22 lines)
and BRETTENHAM HOUSE,
LANCASTER PLACE, STRAND, W.C.2.
Tel.: TEM. 1515 (12 lines)

BT. 23

PERFORATED METALS FOR ALL PURPOSES

POOL LTD
ESTD 1823

HAYLE, CORNWALL Tel. Hayle 3213

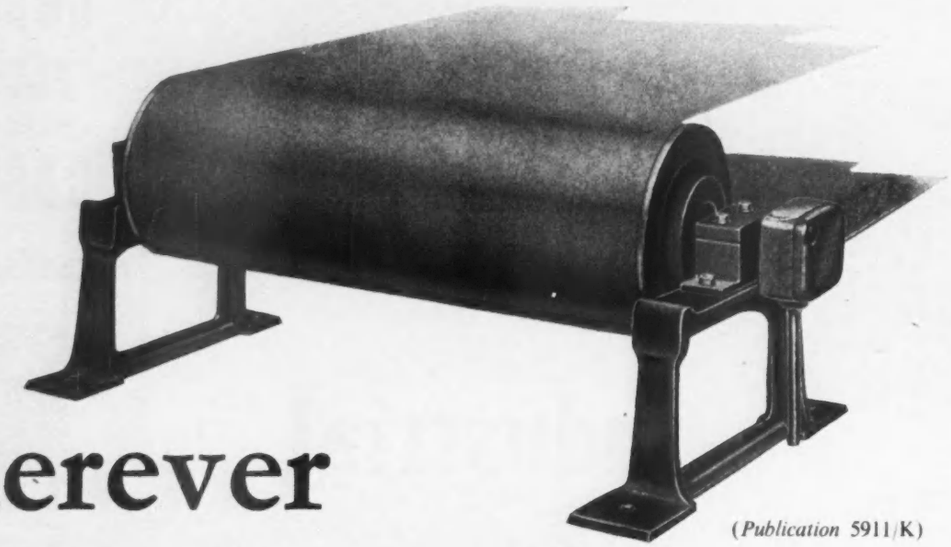
Increase production!
by using
SCRIVEN MACHINE TOOLS

CROSTHWAITE FURNACES and
SCRIVEN MACHINE TOOLS LTD.
York Street Ironworks, Leeds 9 Tel.: 32411-2
32, Victoria Street, London, S.W.1 Tel.: Abbey 2966

GREY IRON
ALUMINIUM
NON-FERROUS
CASTINGS
AND
MACHINED ASSEMBLIES

also
DIE CASTINGS IN ALUMINIUM MAZAK, LEAD & TIN ALLOYS

ECLIPSE FOUNDRY & ENGINEERING CO. (DUDLEY) LTD.
BRITANNIA WORKS,
SEDGLEY ROAD, WEST
TIPTON, STAFFS.
Telephone: TIPton 2545 (3 lines)



(*Publication* 5911/K)

Wherever power is used Crofts Conveyor Drives play a vital role . . .

CROFTS 'RITESPEED' MOTORISED CONVEYOR PULLEY

Check these advantages:

- A single unit, self-contained conveyor pulley with integral drive
- All driving mechanism (electric motor, speed reduction gear) housed inside the pulley itself
- Absence of external drive saves floor space
- Available from stock in a variety of diameters and face widths for a wide range of conveyor speeds, for powers up to 10 h.p. Larger sizes, up to 30 h.p., on short notice
- Ancillary equipment, including bearings, dead-eyes and floor stands, also available ex-stock

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

Head Office: Thornbury Bradford 3 Yorkshire

Telephone: 65251 (20 *lines*) *Telegrams: 'Crofters Bradford Telex'* *Telex* 51186

Branches at: Belfast, Birmingham, Bristol, Cardiff, Dublin, Glasgow, Ipswich, Leeds, Liverpool, London, Manchester, Newcastle, Northampton, Nottingham, Sheffield, Stoke-on-Trent *Representation throughout the World*

THE ENGINEER

No. 5395 JUNE 19, 1959 VOL. 207

THE PRINTING DISPUTE

As we go to press it looks to be a high probability that this somewhat truncated issue will be the last normal issue to be published until a dispute in the printing industry has been settled. For as from the end of this week (if not before) work will be at a standstill at our printers. We shall, as a matter of course, examine what possibilities there may be for publishing regularly some kind of issue, even if it be one only of a few pages, which could carry some engineering news. The outlook is not without promise that we shall be able to do so. We therefore apologise in advance to readers and advertisers for any future shortcomings, assuring them, however, that it is through no fault of ours that we may be forced, temporarily, either to cease publication or to publish much less than usual.

In this editorial office we have, for obvious reasons, less understanding of the roots of the dispute between the Master Printers and the printing unions than about similar situations which have developed from time to time in the engineering industry. For it is, of course, our business to know a good deal about the latter. Whereas we are not in the printing business ; we are merely served by it ; so that we do not follow the ins-and-outs of its wage negotiations. Thus we do not feel competent to comment in any detail upon a dispute whose effects, nevertheless, cause us, our readers and advertisers to be numbered amongst the chief sufferers. Rather more than a month ago it seemed to us that a sane and reasonable basis for discussion had been found between masters and unions, capable of leading to a peaceful settlement of a dispute which had arisen over a claim for higher wages and shorter hours of work. For the masters seemed willing to concede much that the unions wanted provided that costs were not increased thereby. Costs, it appeared, would not be increased were certain restrictive practices given up by the unions and more co-operation offered by them towards the use of high production machinery, &c. In fact the masters were saying what economists have been saying for years and other employers in a variety of industries have repeatedly tried to say, that any increase in wages ought to be related to increases of productivity so as to keep costs and prices stable. For a time we thought we were to see the point conceded by a union. But somewhere along the line in the negotiations that followed there came a failure. We have little notion where. Now each side regards the other as intransigent. Tempers have risen. There is to be a trial of strength. In this year towards the end of the twentieth century it seems to us deplorable that employers and employees in this or any other industry should feel a need for battle, considering that sooner or later the issues concerned must be settled by negotiations. It seems to us especially deplorable in the printing trade in which, traditionally, up to the end of the last war, disputes had been settled peacefully, as witness the fact that up to 1950 there had been no interruption in the publication of this journal since it was first started in 1856, save only for a couple of issues lost during the General Strike in 1926, and another couple lost by governmental behest during the fuel crisis of 1947.

We have referred to this issue in the foregoing as " truncated." As it includes a two-page art plate and a 32-page Supplement readers may, perhaps, feel that the description is hardly appropriate! But, in fact, the issue itself is only a few pages larger than half its usual size ; and as for the Supplement we originally contemplated publishing it, not with this, but with next week's issue. By the time, however, that a printing schedule had to be arranged, it was clearly wise to aim for the earlier date of publication. Fortunately, also, the relationship between the proprietors of this journal and its printers, George Reveirs, Ltd., has always been good ; and the relationships between the editors and all concerned at the printers have been excellent for a hundred years and more. Consistently, therefore, with commitments to their unions, our printer's men have had no active desire to prevent us from doing things we had planned to do long before the printing dispute reached its present pass. Hence our ability to publish with this truncated issue a Supplement on " Swiss Achievements " which, we believe, will be of great interest, not only to the members of the Institution of Mechanical Engineers, who are to visit Switzerland the week after next, but to many other engineers besides.

TRAWSFYNYDD NUCLEAR POWER STATION

As announced elsewhere in this issue the Central Electricity Generating Board has issued a letter of intent to Atomic Power Constructions, Ltd., to contract for the building of a 500MW nuclear power station at Trawsfynydd in Wales. Work on the station is due to start on July 1. Five British consortia will then be engaged in building the first five nuclear power stations at home to be designed purely for electricity generation. Two of the consortia (The Nuclear Power Plant Company, Ltd., and the G.E.C.–Simon-Carves group) will also be engaged in building nuclear power stations overseas—one in Italy and one in Japan.

Of the Trawsfynydd project itself little can be said beyond the bare outline, until the contractual details have been settled. Perhaps the main point of interest is that the nuclear power station will be very closely linked as an operational unit, by a 275kV overhead transmission line, with the pumped storage hydro-electric scheme at Blaenau Ffestiniog, about 5 miles away. Ffestiniog, which will have an output of 300MW and a pumping input of about 400,000 h.p., will help to provide an off-peak load to give the nearby nuclear power station a high load factor, without which the output would be uneconomic. It is anticipated that the pumped storage station will be supplying peak loads, mainly in the winter, for about 4½ hours a day on five working days per week. and that the pumps will be run for about 6½ hours on

each of the five nights. North Wales, then, will provide the world's first full-scale testing ground for the promising partnership between pumped storage and nuclear power. Unfortunately the scope for similar schemes in Great Britain is limited and the future of nuclear power generation in this country will depend very much upon the success of her efforts to reduce the capital cost and at the same time to raise the load factor.

REVIVAL OF VENETIANS

That old invention, the Venetian blind, has made a startling come-back since the war. Of course, a hundred years or so ago, no large Victorian house was considered complete which had not an example fitted to almost every window. But why that form of blind was quite so popular at that time we are not very certain. Had it, we wonder, something to do with the prevailing impression of the day that direct sunshine was harmful to ladies' complexions ? Or was it merely that Victorian dyes were so far from fast that if colours were to be preserved at all, wall-papers, furnishings and fabrics had all, somehow, to be protected from the sun ? Certainly those old blinds did have the advantage of letting in plenty of light on a sunny day whilst excluding the sunshine. But, as older people will remember, it was about the only advantage they did have. All else was disadvantage. The heavy wooden slats collected dirt and were difficult to clean ; they were also easily chipped or broken. The supporting cords, too, easily rotted ; so that, disconcertingly, one day one side of the blind would come down with a rush, leaving the other side up. This created a dilapidated appearance, if not, indeed, a drunken one. Such defects could be borne when there were ample servants available to clean and repair the blinds ; but not in our servantless age.

At least two things have contributed to a revival of liking for Venetian blinds. The first and probably the more important is the penchant of modern architects for providing very large window spaces. The second is the advent of new materials. Now no one objects very strongly to large windows ; for their appearance is often good. But when a whole side of a room consists of glass, certain inconveniences follow. It is, of course, pleasant enough to sit in such a room on a fine summer's day with a feeling that one is almost in the garden. It is not so pleasant upon a gloomy December afternoon, with rain drizzling down ! Again, in December, it is important, especially in an office, that as much light as possible shall be let in. But, unfortunately, there is the disadvantage of a larger window that a stream of cold air comes down from it and spreads across the floor. Moreover, in summer, just when the outlook is at its best, the sun comes streaming in, blindingly, and not a corner of shade is to be found. Unless a complete air-conditioning system has been installed, conditions can soon resemble those of a greenhouse. We know of one very well-known elderly engineer who has had to have installed in his new, modern and centrally heated office batteries of radiant electric fires to keep him warm in winter as he sits by the window ; and who, lest he be roasted, scarcely ever raises the blind in summer !

The providential answer to these problems is the Venetian blind, made nowadays not of heavy slats of wood, but of thin curved slats of anodised aluminium or plastics. Such blinds are made in surprisingly large sizes. Within reason, they are almost indestructible ; and their appearance is decorative. The other day we saw one no less than 130ft wide, believed to be a world record. It is 7ft deep and is operated by a single electric motor. It has been made by Venetian Vogue, Ltd., and installed in the office building of Bell's Asbestos, Ltd., at Slough. The slats are of aluminium ; cords are of "Terylene," strong, almost invisible, and nearly indestructible. This blind will, it is expected, serve not only to keep out unwanted sunshine, but also to counter by its presence the downcurrents of cold air generated by the large window space. Heat losses through the window are, it is claimed, almost eliminated, with resultant fuel savings ; and on dull days, because each slat can be positioned to reflect light into the room, there may prove to be economies in the use of electric light. Strange, is it not, how new materials, fresh minds and new architectural fashions can raise old outmoded ideas from the dead to vigorous life again !

The Engineer—100 Years Ago (JUNE 17, 1859)

"WHAT SHOULD MECHANICAL WORKMEN BE TAUGHT ?"

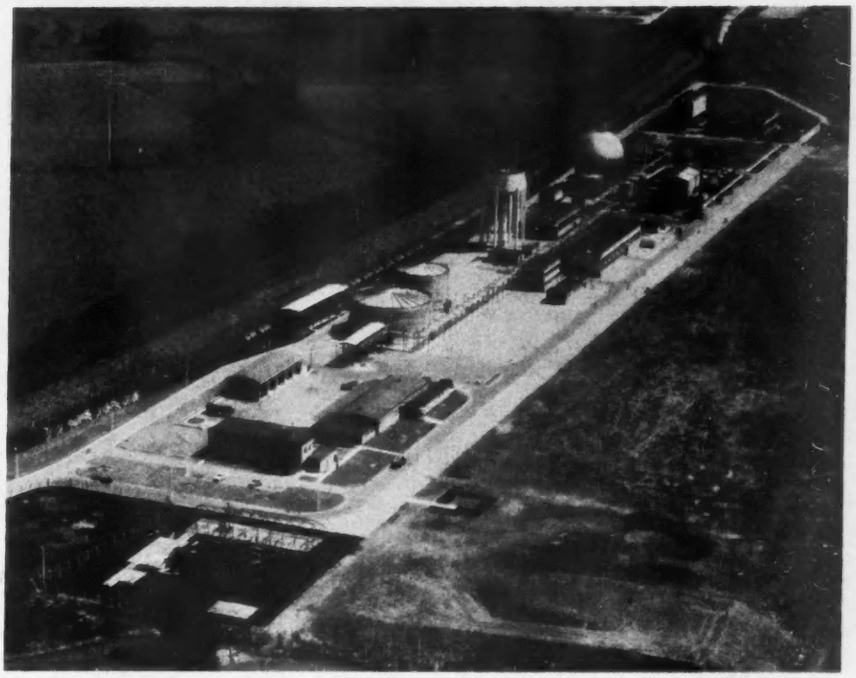
"A few days ago, Mr. Scott Russell delivered a lecture at the Brompton Museum on the kind of education mechanical workmen should receive. Mr. Russell stated that the education provided in this country was not that which was very directly calculated to make good workmen. Reading, writing and drawing, he thought very good for the skilled workmen, as well as everybody else ; but it did not at all consort with his experience that the best reader and the best writer were always the most skilled workmen. On the contrary, the best workman he ever knew could neither read, write, nor account. Nevertheless, he maintained that there was a description of education which would tend greatly to increase the skill, dexterity, ability and success of the practical working mechanic. He knew that other countries were giving this superior education to their workmen, who were in many cases now so far superior in theoretical skill to ours, whilst practically equal, that he was obliged to get his very best draughtsmen and mechanics from foreign countries.

"He thought our Government might be induced to do something in this direction. He did not discourage the teaching of drawing, reading, writing, and accounting, but would have them continued to be taught in the best manner. . . . . He would teach mechanics the very little that was useful in Euclid—the law of the lever, plane trigonometry, solid geometry, conic sections, and the nature of curves of the first, second, third and fourth degree. This constituted the whole education of a workman. Direct elementary text-books, however, were not to be had in the higher branches of mechanics, and he wanted the Department of Science and Art to ask the four cleverest men in England to write in the fewest possible English words all that they knew, not all they had read, but, in fact, all that they carried about with them. If Government would give a thousand pounds a-piece for these books, he was sure they would be written."

Nitrogen Factory at Stanford-le-Hope

By L. O. WHITTAKER, M.I.Mech.E., M.I.E.E.*

On Tuesday of last week, Lord Netherthorpe, president of the National Farmers Union, officially opened a nitrogen factory which has been built at Stanford-le-Hope, Essex, for Fisons, Ltd., at a cost of £4,500,000. The site on which this plant stands covers 63 acres on Thames-side, of which 25 acres have so far been developed. Construction work began in April, 1957, the plant being completed by February of this year.



THE decision of Fisons, Ltd., to manufacture ammonium nitrate was based on a requirement for nitrogen in a more concentrated form than hitherto available for the production of granular compound fertilisers. Prior to the opening of this new factory, the material used as a nitrogen source was ammonium sulphate (21 per cent N). The replacement of ammonium sulphate by ammonium nitrate (35 per cent N) permits the manufacture of more concentrated compound fertilisers containing the three essential plant food elements, namely, nitrogen, phosphorus and potassium. Ammonium nitrate is manufactured from ammonia by a two-stage process, part of the ammonia being first oxidised to nitric acid which is subsequently neutralised with the remaining ammonia. The final product is an aqueous 86 per cent solution of ammonium nitrate which is conveyed hot to the various compounding works all over the country in road and rail tankers. Fisons, Ltd., has an agreement with Shell Chemical Company, Ltd., to purchase nitrogen, part as liquid ammonia and part in the form of nitric acid, from the latter company's nearby plant at Shellhaven. These liquids are conveyed by pipeline as are quantities of cooling water and refinery gas which are taken from Shellhaven.

The contract for the nitric acid plant at Stanford-le-Hope was awarded to the Chemical and Industrial International of Nassau, Bahamas (C. and I.I.), which company was also awarded the contract for the ammonium nitrate plant, under licence from Commercial Solvents Corporation of New York. Brian Colquhoun and Partners were the civil engineering consultants, being directly responsible to Fisons, Ltd. Under their direction, Sir Lindsay Parkinson and Sons undertook the erection of the administrative buildings, process plant foundations and road-rail services, while James Miller and Partners carried out site levelling and all civil engineering works in connection with the cooling water system and approach underpass. Constructors John Brown, Ltd., was associated with C. and I.I. in the construction of the process plants and was also responsible directly to Fisons, Ltd., for the design and construction of the offsite facilities.

Although the Fisons and Shell boundaries are relatively close together, the area between is traversed by the Thames Haven branch line of British Railways. The problem of installing the intake pipelines without interruption to railway operations was solved by the provision of two 42in diameter thrust bores through the railway embankment. As a safeguard, the chemical lines are grouped together through one thrust bore and valved at both ends for emergency isolation. Once through the thrust bores, the cooling water line remains underground to its points of utilisation but the chemical pipes are carried above ground initially on low level pipe supports and thereafter at high level through the process area.

The liquid ammonia is stored in a 2000-ton capacity, 60ft diameter steel sphere erected by Whessoe, Ltd., which is illustrated herewith. The vapour pressure is maintained automatically at 52·5 lb to 57·5 lb per square inch gauge by a pressure switch actuating a Sterne refrigeration system. To assist in maintaining the required temperature, the sphere, including its support legs, has been lagged with 3in thickness of expanded ebonite insulation ; it is weather-proofed all over and finished in an aluminium colour. A Shand and Jurs ST–9400 high pressure automatic tank gauge facilitates observation of the liquid content from ground level and the transfer of ammonia is effected by three Sigmund multi-stage barrel pumps with " Flexibox " mechanical seals. The incoming nitric acid is stored in a 100,000 gallons capacity, 30ft diameter by 24ft high stainless steel (EN.58B) storage tank. This tank, with self-supporting roof, was also supplied and erected by Whessoe, Ltd., all the vertical seams being spot X-rayed. Liquid level indication is by means of a " Pneumercator " level gauge and a high level alarm is fitted. In addition, three 40,000 gallons capacity, 17ft diameter by 32ft hign stainless steel shift tanks have been provided for the measurement of nitric acid production and feed ; these were supplied by A. J. Riley and Son, Ltd. Levels in the two product tanks are remotely indicated in the control room in the nitric acid plant building. The transfer of nitric acid is achieved through Hayward Tyler chemical and process pumps, all contact parts being of stainless steel. Flexible stainless steel bellows have been fitted in the piping systems to compensate for any relative movement.

In the nitric acid plant a modified du Pont process is employed. Filtered air is compressed to 120 lb per square inch in a 7000 h.p. Brown Boveri nine-stage centrifugal compressor. About two-thirds of the power required to drive the compressor is supplied by a Brown Boveri waste gas recovery turbine and the remainder by a Belliss and Morcom condensing steam turbine. The air is mixed with ammonia and reaction takes place on platinum rhodium catalyst pads in a converter, shown in an accompanying illustration. Sufficient heat is generated to maintain a catalyst temperature of about 940 deg. Cent. The hot gases, containing oxides of nitrogen, are first cooled in a series of heat exchangers, the surplus heat being used to generate steam. Final cooling is achieved in a stainless steel zinc-coated serpentine cooler, sprayed with Thames water. The cold gases are mixed with a secondary stream of air and passed into a bubble-cap absorption tower, where they are absorbed in water to form nitric acid. The

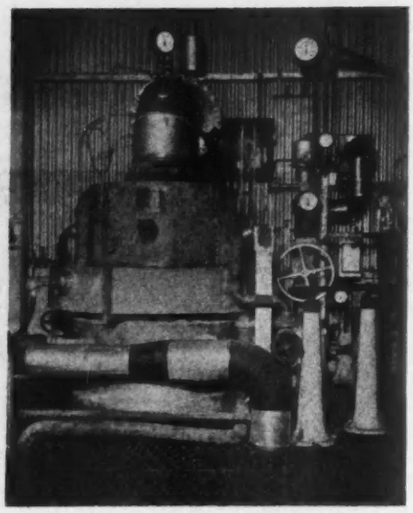
* Chief Engineer, Fisons, Ltd.

product flows continuously to storage under its own pressure.

As the waste gases leaving the tower still contain traces of nitrogen oxides, fuel gas is injected at this point, and the mixture is passed through a catalytic fume eliminator which converts nitrogen oxides to harmless nitrogen. Heat produced in this reaction is recovered as steam in a waste heat boiler. The purified tail gases, under a pressure of about 80 lb per square inch, pass through the gas turbine which forms part of the air compressor unit, and thence to atmosphere via a stack. More than sufficient power to operate the plant is recovered by the gas turbine and as steam. Steam which is surplus to the requirements of the turbine is passed out to the factory.

The process is continuous except for a short shut-down every three weeks for replenishment of the platinum-rhodium catalyst. The plant is fully instrumented and will shut down automatically and safely should variations from desired operating conditions occur.

For the ammonium nitrate plant, the Stengel process, operated under licence from the Commercial Solvents Corporation of New York, is used. Nitric acid and ammonia are mixed in a specially designed reactor to give an 86 per cent solution in water of ammonium nitrate. Nitric acid is pumped through a heater into a mixing chamber in the top of the reactor, where it meets a stream of ammonia vapour. The mixture passes down through the reactor which is essentially a stainless steel tube packed with stainless steel rings, and sufficient heat is developed to boil off some of the water present in the nitric acid. Ammonium nitrate solution and steam from the base of the reactor flow through a separator, from which the ammonium nitrate product is



This nitric acid plant converter contains platinum-rhodium gauze pads, through which ammonia is passed, converting it to oxides of nitrogen

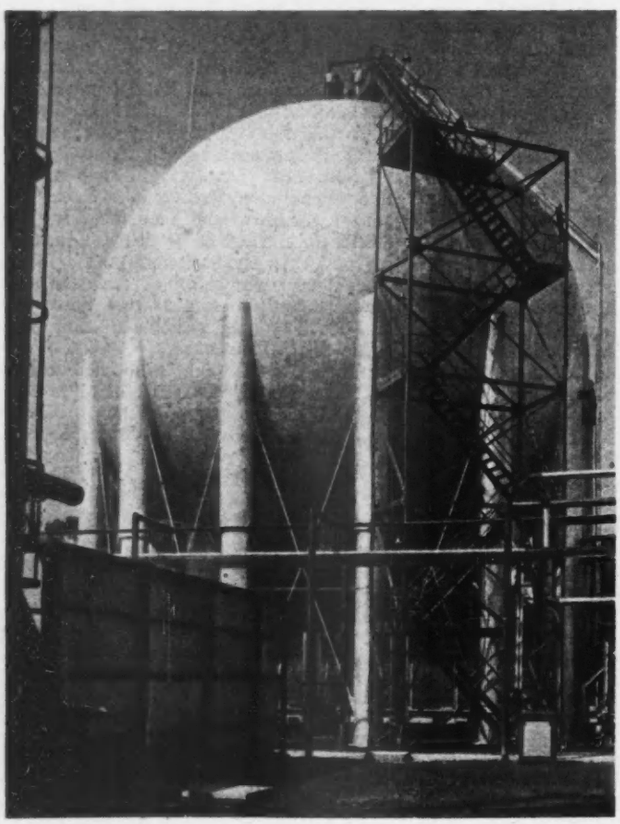
pumped continuously to storage through steam traced lines. The plant is very highly instrumented to ensure accurate control of operating conditions.

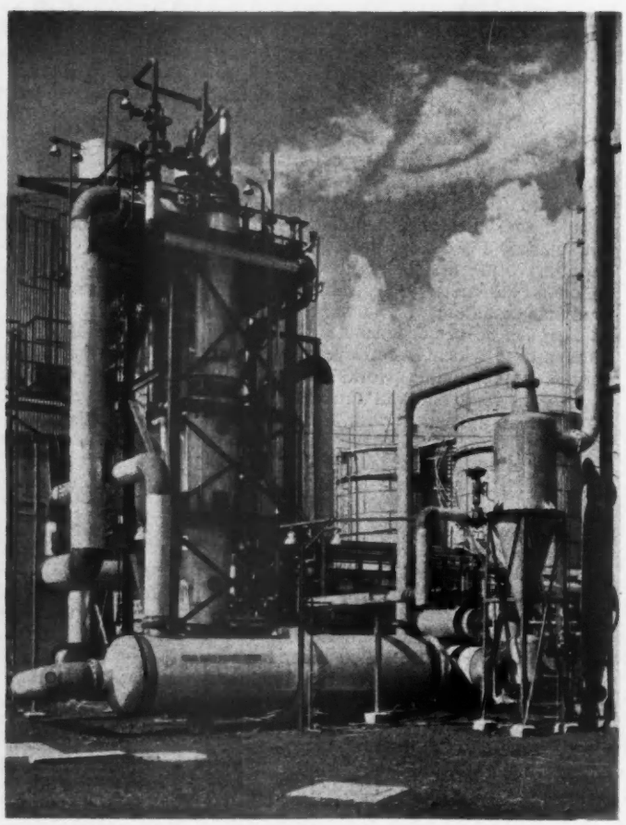
The finished product, ammonium nitrate solution, is stored in liquid form in two stainless steel tanks, of 1,000,000 gallons (80ft diameter by 32ft high) and 500,000 gallons capacity (56ft diameter by 32ft high), both of which were supplied and erected by Whessoe, Ltd. As it is essential to maintain the product temperature at 120 deg. Cent., these tanks are insulated with 3in thick mineral wool and weather protected with aluminium sheeting. The heat losses are made up by forced circulation of the solution through Jenkins external heat exchangers. Re-circulation is by means of Hayward Tyler single-stage process pumps with jet blending at the tank nozzles. Air-operated diaphragm level indicators and three temperature indicators are fitted round the periphery of each tank. The 1,000,000-gallon tank feeds a pumped ring main system serving the road and rail loading gantries.

The boiler house, a part of which we illustrate, contains four "Powermaster" packaged oil-fired boilers supplied by G.W.B. Furnaces, Ltd. Each of them is rated at 17,250 lb per hour steam when operating at 200 lb per square inch gauge and burning heavy fuel oil of 3500 seconds viscosity. For normal factory operation, the steam demand can be met by one boiler only, supplemented by by-product steam from the nitric acid plant. The remaining boilers are for starting up the nitric acid plant, when superheated steam at 540 deg. Fah. is required by the turbine of the acid plant compressor.

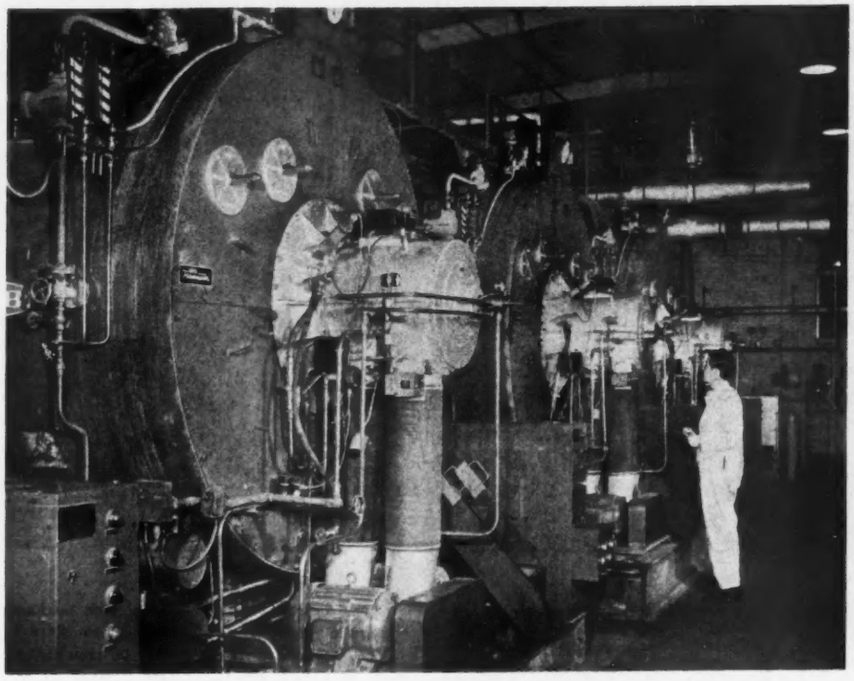
The short term superheated steam demand, together with the selection of automatically controlled packaged boilers, necessitated a separately fired superheater, supplied by Urquharts, Ltd., rated at 35,000 lb per hour maximum and up to 600 deg. Fah. The burner is controlled by a temperature controller in the superheated steam line. To safeguard against overheating of the superheater tubes should a sudden shut-down of the turbine occur, a "low flow" contact was fitted in the steam flow meter which shuts the burner off when the flow falls below 5000 lb per hour.

To meet the requirements of the local authority, a 150ft high boiler smoke stack was provided; it was constructed by Danks of Netherton, Ltd., from Fisons Burwell





(Left) Ammonia from the new synthetic ammonia plant at adjacent Shellhaven is fed to the factory at Stanford-le-Hope and stored in this 2000-ton sphere before being converted to ammonia nitrate. (Right) Eastern end of the compressor house, showing waste heat boilers, tail gas preheater and other equipment, with the nitric acid storage tanks in the background



Boiler house interior. Three of the four "Powermaster" packaged boilers are shown, together with associated equipment

white gault bricks, with an external facing of Saxon sandfaced bricks. On account of the height of the stack, an Electroflo automatic draught regulator has been installed to maintain the suction in the main flue at not more than —0·05in water gauge. The boiler house operations are recorded through a comprehensive instrument panel, an indicating and audible alarm circuit system covering all the key locations. The boiler house pipework and general installation were carried out by Brightside Engineering Company, Ltd.

Boiler feed water is supplied from a Permutit exchange water treatment plant housed in an annexe to the boiler house. Its capacity is 60,000 gallons between regenerations, the maximum rating being 2500 gallons per hour. The treated water is pumped both to the boiler house hotwell and the nitric acid ammonia convertor cooling jackets at rates of up to 50 gallons a minute.

Because of the impracticability of taking water direct from the Thames across mud flats, Thames water for cooling purposes is pumped from Shell Haven to the site through a 24in cast iron main. This pipeline is adequate to supply the full load of 22 cusecs should the factory be operated on the "once through" method, but for the sake of economy the cooling water is normally recirculated over a cooling tower, the rate of make-up being 2½ cusecs maximum. After chemical dosing, the suspended solids are separated in a conical-sided "Aitken" sedimentation tank, from which the clarified water gravitates to the intake pond, being dosed with chlorine *en route* at the rate of five parts per million to inhibit fungal growths. Clarified water from this intake pond is circulated to the process plants by three Worthington-Simpson variable speed pumps each having a capacity of 6000 gallons per minute, one of them being a stand-by. The delivery pressure is maintained within a narrow operating range by a "Pressuretrol" system. The pumps are all of phosphor bronze construction with stainless steel shafts to resist the action of sea water. The cooling water returns through a flume to the cooling tower pond discharging over a rectangular weir. Three Worthington-Simpson pumps (one spare) draw from the cooling tower pond and speed control is by a float operated potentiometer which maintains a constant level in the pond.

The driving motors for the works supply and cooling tower pumps are variable-speed induction regulator controlled machines supplied by Laurence Scott and Electromotors, Ltd., the ratings respectively being 315/155 h.p. at 1050/800 r.p.m., and 130/60 h.p. at 1100/800 r.p.m. Motor control is by means of Laurence Scott "Asrec" automatic control gear and is so arranged that the second pump cuts in as soon as the first pump approaches top speed, at which point the leading pump retards until both pumps are sharing the load. The reverse procedure applies when the load is reduced.

The cooling tower, by Film Cooling Towers, Ltd., is a five-cell unit designed to handle salt water; four cells are normally in use, the fifth acting as stand-by. The tower, when operating on four cells, is designed to cool 494,000 g.p.h. of water from 105 deg. to 80 deg. Fah. at a wet bulb temperature of 64 deg. Fah. Each cell is fitted with two four-bladed induced draught fans, these being driven through Opperman gearboxes by 20/7½ h.p. change-pole, weatherproof Metropolitan-Vickers motors giving fan speeds of 300/200 r.p.m. The tower shell of reinforced concrete is 84ft by 31ft by 38ft high with wood internal packing specially treated to resist sea water. A two-pass spray eliminator is fitted above the packing. The cooled water discharges into the intake pond.

A continuous bleed-off is taken from the recirculated water in order to maintain the solids content at not more than 50,000 parts per 1,000,000. This bleed-off, together with storm water and sludge from the settling tank, is delivered to the estuary pond, from which it is pumped over the sea wall to the Thames Estuary by three Worthington-Simpson 20in constant-speed marine condenser pumps of all-bronze construction, each arranged to deliver 7000 g.p.m. at low head. Each pump is driven by a 50 h.p., 585 r.p.m. Tricelot motor, with sequence direct-on-line starting float switch controlled from the estuary pond.

As to the electrical system, at the main substation the incoming mains 11kV supply is controlled by a six-panel Metropolitan-Vickers switchboard. There are two 500kVA Metropolitan-Vickers transformers for reducing the supply to 415V, three-phase and neutral, 50 cycles system, the low-tension distribution system being controlled through an Ellison seven-unit switchboard. A second substation located at the cooling water pump station is supplied by a single 11kV feeder from the main intake substation and is equipped with a three-unit board of the same kind as in the main substation. Three 500kVA Metropolitan-Vickers transformers feed an eight-unit Ellison switchboard which, in turn, supplies the pump motor control panels. A local low-tension underground distribution system supplies the cooling tower and sewage pumping station.

To enable the factory to continue production should a total power failure occur, a 775kW diesel-driven alternator is being installed. Provision is made for synchronisation with the public supply on restoration of voltage, this being carried out by remote control from No. 1 substation. All the outdoor chemical transfer pumps are driven by weatherproof motors controlled by hand-operated Ellison oil-immersed starters supplied from Simplex weatherproof distribution switch fuse gear.

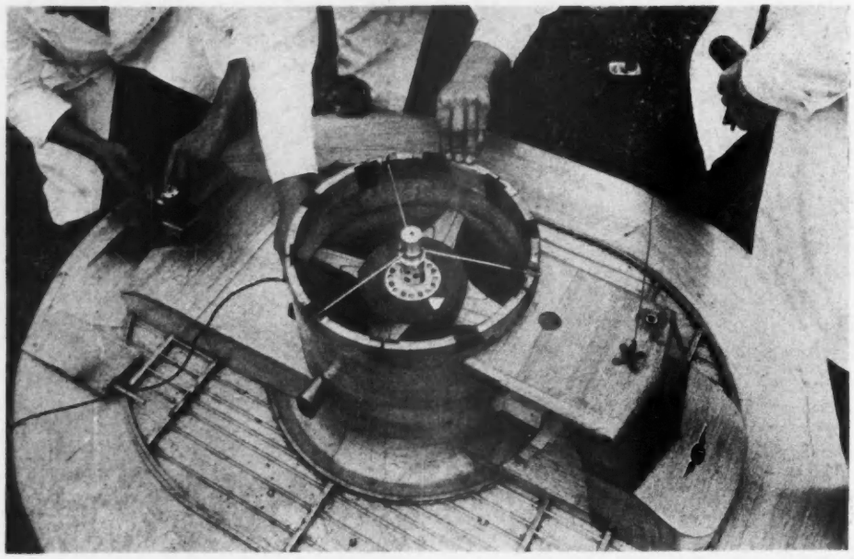
In designing the new plant, particular attention had to be given, of course, to the transport system. Ammonium nitrate solution is despatched by both rail and road to the company's fertiliser compounding works in various parts of the country. A fleet of fifteen road tankers, each of 2400 gallons capacity, is operated under contract by Road Services (Caledonian), Ltd., loading and delivery being on a twenty-four-hour basis. Eight of these tankers can be filled in an hour at a gantry with four loading points. In addition, two articulated road vehicles are provided for conveying liquid ammonia to the compounding works as required. For rail delivery there are forty-five tank wagons, each of 3300 gallons capacity; they are fitted with stainless steel barrels designed for a working pressure of 30 lb per square inch gauge. These tankers, supplied by Charles Roberts and Co., Ltd., have been designed for a maximum speed of 70 m.p.h. and are fitted with vacuum brakes. One train, consisting of fifteen cars, can be loaded in from five to six hours, and British Railways provide an express service from the plant to the Immingham and Avonmouth Works. A liquid ammonia tanker can also be attached to each train when required. The freezing point of 86 per cent solution is approximately 85 deg. Cent. and ample margin is provided by the temperature of the solution as filled to prevent crystallisation *en route*.

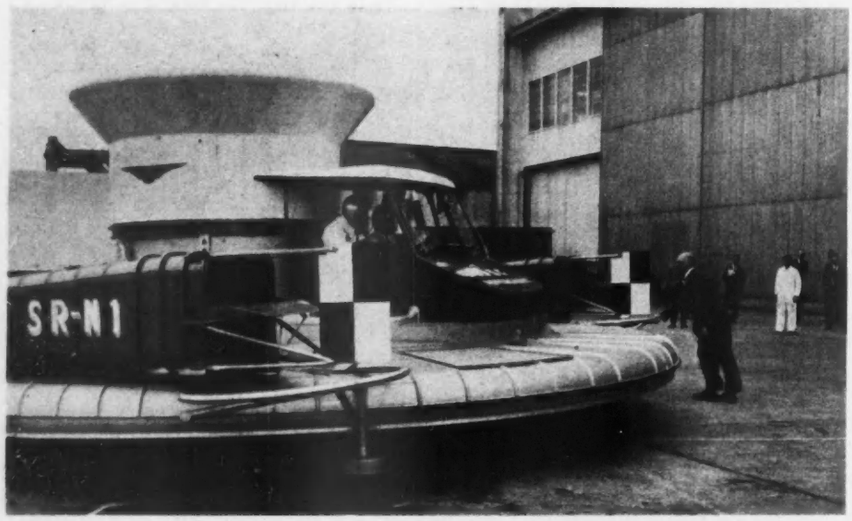
Access to the new works from Stanford-le-Hope has involved, as already mentioned, crossing the Thames Haven branch line and an underpass is now under construction which will ultimately provide an 18ft wide roadway with 6ft path and 15ft 6in clear head room.

The new factory includes a well-equipped workshop, a spacious single-storey laboratory building, a large welfare building, which incorporates staff and works canteens, and an imposing two-storey main office block. Adjacent to the main entrance to this office building there is an imposing 8ft high anodised aluminium sculpture depicting "strong and vigorous plant growth." This sculpture, the work of Mr. Bernard Reynolds, of Ipswich, was unveiled by Lord Netherthorpe on the occasion of the official opening.

Ground Effect Aircraft

There was demonstrated last week at the Cowes works of Saunders-Roe, Ltd., the "Hovercraft" research vehicle built under the sponsorship of the National Research Development Corporation. The principle of operation is closely related to that of the jet flap, a pressure difference being sustained by the change in momentum of the jet sheet: the product of "cushion" pressure and hovering height has proved to be, as simple theory predicts, the change of momentum in deflecting the jet sheet into the horizontal plane. One feature of this design which is claimed to be distinctive is that the initial direction of the jet is not vertical but inwardly inclined to increase the pressure developed. To minimise the energy demand for a given momentum change, low pressures are optimal, and the manned research vehicle supports 10 lb per square foot within the "curtain" at its periphery and 17 lb per square foot within a second curtain 3ft further inboard.

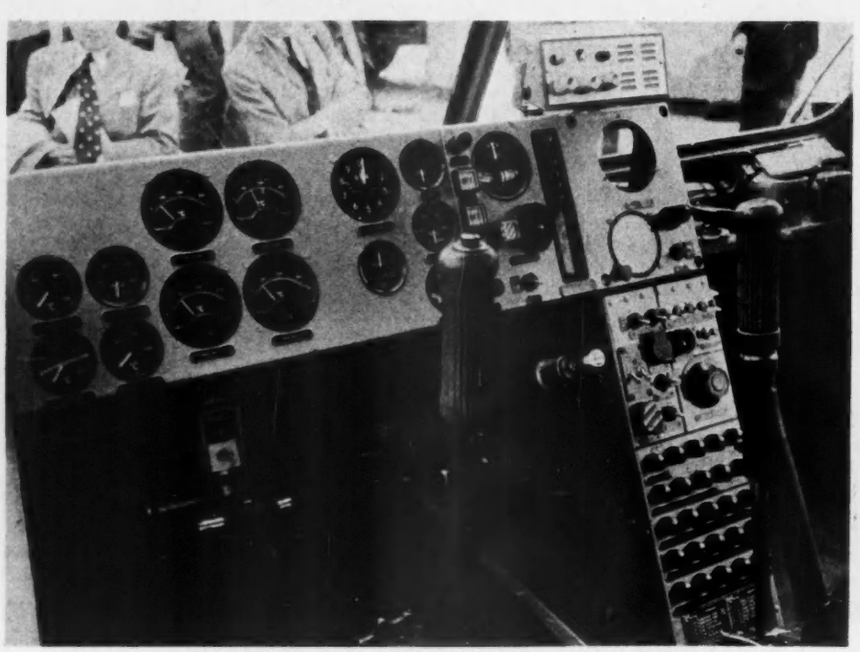




The anticipated applications of such machines were outlined in our previous article (May 1, 1959, page 700). It can readily be seen that as the size increases the power demand of the curtains increases linearly but the lift as the second power of a dimension, and although larger machines must be designed for greater operating heights there is expected to be a substantial change in power/weight ratio with size: the development machine weighs about 7500 lb and has a 435 h.p. Alvis "Leonides" helicopter engine. In its initial configuration it is expected to attain about 25 knots at a height of about 15in.

The TOP illustration shows a dynamically similar machine built for model tests: it has been "flown" over waves in a towing tank to predict the behaviour in high seas, leading to the expectation of performance much superior to that of a conventional hydroplane. The model is built on normal lines of balsa and tissue: it is powered by model aircraft engines, the lift engine spark ignition and the thrust engine compression ignition.

The CENTRE picture shows the "SR-N1" hovering: it is, in effect, floating on an air bearing, and the inventor, Mr. C. S. Cockerell, is seen in the act of moving the machine. In the foreground can be seen one of the four propelling nozzles with the control vanes that allow a transverse or vertical component of thrust to be developed. The yaw vanes at the rear nozzles are extended upward to give directional stability and improved yaw when flying forward. Acceleration is controlled by altering the distribution of air between forward and aft nozzles by means of vanes in the ducts. The cabin, RIGHT, includes apparently normal controls, the rudder pedals rotating all the vertical vanes in the same direction and the joystick rotating all the horizontal vanes in the same direction when it is moved fore and aft and oppositely in diagonal pairs when it is moved sideways. A thrust lever at the pilot's right distributes the propulsive effluent: at the demonstration the tail of the machine was ballasted so that the machine hovered with this lever in the forward sector. The instrumentation is largely engine supervisory gear, the four large dials being temperatures at various points on the power plant. The crew, a pilot and an observer to monitor the instruments, wear protective helmets as a precaution against disintegration of the fan behind them.



St. Lawrence River Development

IV—LIFTING BRIDGES

Here we digress to give a brief note on the history of Victoria Bridge, and then we describe two lifting bridges of contrasting design, which may be taken to typify such construction on the whole of the Seaway project. The first of them is at St. Lambert lock, but the second is further upstream at Caughnawaga.

IT will be of interest to many readers of this journal if, before describing the lifting bridges at St. Lambert lock, we digress from the Seaway itself to give a few brief details of the Victoria Bridge, the centenary of which, appropriately enough, falls this year, the bridge having been completed on November 24, 1859. The bridge was built by Robert Stephenson for the Grand Trunk Railway Company ; a description of it, published in THE ENGINEER of December 16, 1859 (and also of September 9, 1859), records the magnitude and difficulty of its construction, and also some criticism, as follows :

" The Victoria Bridge, thus named at the commencement of its construction, is an iron tubular bridge of 25 spans, covering a clear opening of 6,540 ft., or nearly 1¼ miles, between the abutments. The great river flowing beneath has an exceedingly rapid current, and when the ice, into which its surface is always deeply frozen in winter, breaks up and floats off in the spring, it acquires such an immense momentum, that only the very strongest constructions could stand for a moment in its course. The masonry in the piers and abutments is, therefore, of the most massive character, the stones averaging 10 tons each in weight. The entire masonry, of which there are 3,000,000 cubic feet, is said to have cost about £1,000,000 or £40,000 for each pier. The piers have sloping faces up-stream, and these are also made to slope gradually from a blunt central edge, in order to intercept and break floating ice, with less strain upon the piers than if their up-stream faces were vertical and at right angles to the current. The superstructure consists of 24 tubular spans of 242 ft. clear opening each, and one central span of 330 ft. Although, in respect of the width of single spans, there are other bridges which surpass the one under notice, the Victoria Bridge, as a whole, is incomparably the greatest example of pontine construction extant—as much greater than other large bridges as the Great Eastern is greater than other large ships. The cost of this immense structure, for a single line only, is reported at nearly £1,500,000 and in the presence of these formidable figures we feel justified in criticising the design and proportions of the work. £75,000 of annual interest is a large tribute for the privilege of crossing the St. Lawrence, more especially from a railway company, which, whatever may be its credit, has never enjoyed such circumstances or prospects as would justify such an outlay for such a purpose. . . . . "The Grand Trunk Company never could, and never can, afford such a work, especially whilst one, practically as strong, and every way as useful, might have been erected for two-thirds the cost, which even then, would have been enormous. As a work of engineering, we trust it will be the last in which the outlay is so disproportionate to the end."

The single-track tubular bridge was replaced about forty years later, by Joseph Hobson, the chief engineer of the Grand Trunk Railway. The new superstructure consisted of steel truss spans on the old piers, each span carrying a double-line railway between two pin-connected " through " Pratt trusses, and with a roadway cantilevered out on each side (see THE ENGINEER, October 1, 1897). This is the form in which the bridge is used to-day, although the cantilevered roadways have been improved and are now each 16ft wide. Nowadays, about 120 trains cross the bridge daily, and road traffic reaches a maximum of 2000 vehicles per hour and totals over 25,000 per day. This heavy usage would seem to refute

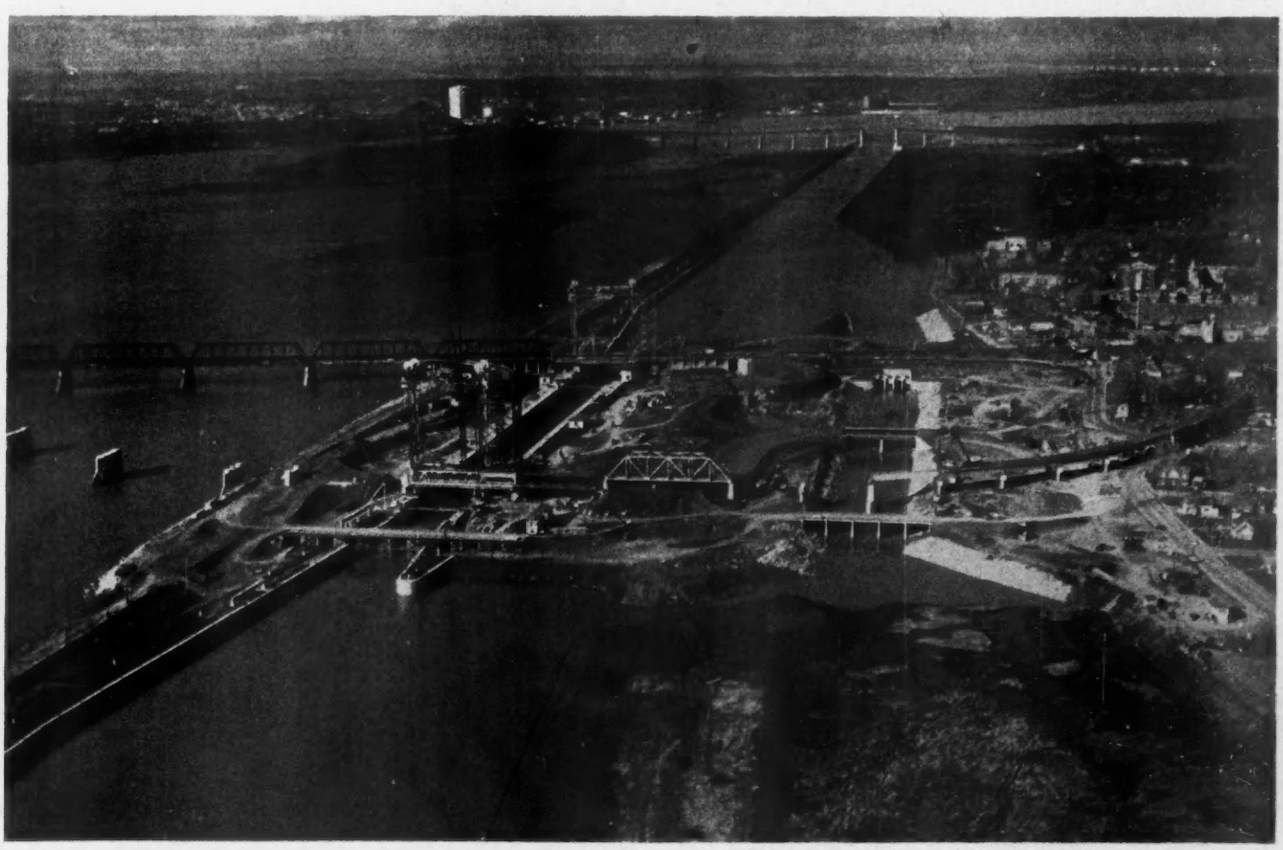


Fig. 17—St. Lambert lock and its two lifting bridges shown at an advanced stage of construction. In the foreground is a temporary trestle bridge for road traffic, to the right the St. Lambert drainage culvert, and in the background the Jacques Cartier bridge, a reclaimed area, and the Seaway entrance. The alternative road and rail routes across Victoria bridge using the two lifting bridges can be clearly traced from this illustration, remembering that road traffic keeps to the right. The piers in the river and the plate girder bridge to the right are the railway spur

our criticism of 100 years ago, but it may be worth mentioning that tolls are still charged for road vehicles.

The difficult work of underpinning the pier and abutment respectively on the north and south sides of the Seaway has already been referred to. The new arrangement with dual lifting bridges at St. Lambert lock will now be described.

Lifting Bridges

The illustration (Fig. 17) shows road and rail spurs serving the two lifting bridges at St. Lambert lock. Both bridges take road and rail traffic. In operation, assuming a ship is travelling upstream, the sequence is (*a*) divert traffic to upstream bridge; (*b*) raise downstream bridge. The ship then enters the lock. (*c*) Lower downstream bridge. The time taken to operate the lock gates and to allow the lock to fill to the upstream level is then sufficient for traffic to be diverted back to the downstream bridge, prior to the last stage (*d*) in which the upstream bridge is raised and the ship proceeds up the Seaway. Thus uninterrupted land and water routes are ensured by this dual bridge arrangement. It appears however, that operation on this principle is likely to become complex if the Seaway locks are duplicated, when there will be possibility of two vessels locking almost simultaneously.

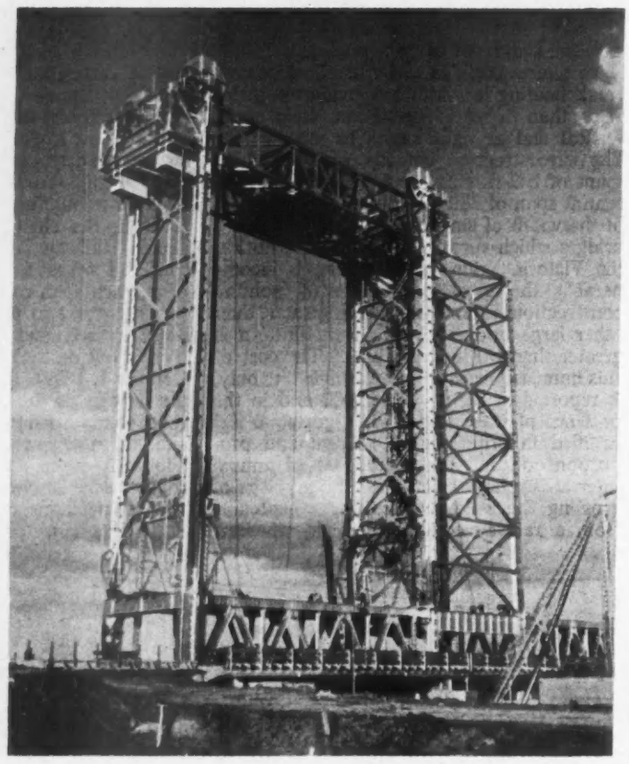


Fig. 18—Upstream lifting bridge at St. Lambert lock. Two railway tracks are carried at the upper level of the lifting span, dual carriageways at the lower level

We have already indicated that there was virtually no alternative in siting the St. Lambert lock; similarly, permissible gradients for the railway dictated the use of lifting bridges. During construction road traffic was diverted over a temporary bridge, and along roads clear of the lock. The downstream lifting bridge was then constructed in stages, following a rather complicated plan, keeping the railway in operation throughout the entire replacement of the old Victoria bridge span by the new lifting span, but with limited periods of single-track working or possession of both lines.

The upstream lifting bridge was built without the complication of traffic usage, and its erection was therefore straightforward. This bridge is very similar to the downstream one, the major difference being that the lifting span is a double-deck Warren truss, as shown in Fig. 18, carrying the double-track railway at the top chord level, and a four-carriageway road at the bottom chord level. By contrast, the downstream bridge has a lifting span which is a "deck" girder, carrying the double-track railway, and, in the manner of the Victoria bridge, a roadway cantilevered on each side of it.

In the ensuing description, we have concentrated on the downstream bridge, the principal structure and a number of the auxiliary mechanisms of which are shown in the accompanying inset drawing. The inset drawing also shows details of one of the pair of lifting bridges, further upstream in the Lachine section of the Seaway, at Caughnawaga. The St. Lambert bridge has a lifting span of 115ft being built at a lock, whereas the Caughnawaga bridge spans the Seaway canal itself, and its lifting span is much greater, being 332ft. It is thus designed and built in a different manner from the St. Lambert bridge, so these two bridges are good examples to take to exemplify lifting bridge construction on the Seaway generally.

St. Lambert Downstream Bridge

The structure of the downstream lifting bridge at St. Lambert lock at the track and roadway level consists of the lifting span—a "deck" plate girder span over the 80ft wide lock spanning about 108ft between bearing centre lines—a 53ft "tower" span, and short approach spans to total the 260ft of the former span 25 of Victoria bridge. All spans carry double-track railway with a 16ft roadway on each side. At each end of the lifting span a tower 175ft high supports the counterweight sheaves. A fixed overhead bridge joins the tops of the towers and supports the machinery which raises and lowers the span. All of this can be seen in the inset drawing. At each end of the span a counterweight is connected to the lifting span by wire ropes passing over the counterweight sheaves. Each counterweight consists of a steel box filled with concrete and having three precast concrete auxiliary counterweights suspended from it. The entire span is 115ft long, 78ft wide and weighs 590 tons; it can be lifted 97ft.

Design followed Canadian Standards Association specifications for class E60 railway loading on two tracks; highway loading was for a 13½-ton two-axle vehicle on each road or a distributed load of 75 lb per square foot of roadway, for the design of principal structural members, but for the deck scantlings 100 lb per square foot or a 20-ton vehicle were taken. Wind load was assumed to be 30 lb per square foot for the loaded bridge or the bridge when lifted, but 50 lb per square foot for the unloaded, closed condition. Additional allowance was made for loads due to impact and operation of the bridge. The steel used was the C.S.A's medium structure steel (C.S.A. G40-4) and structural rivet steel (C.S.A. G40-2) for the $\frac{7}{8}$in and $\frac{3}{4}$in rivets in the bridge. The dead load of the bridge deck is 825 lb per foot for each track. The design provides for the possibility of electrifying the railway.

The weight of the lifting span is fully balanced by the counterweights. Each corner of the span is connected to the counterweight by twelve $1\frac{7}{8}$in wire ropes passing over a counterweight sheave 15ft in diameter weighing 17 tons. The span is raised and lowered by two $1\frac{1}{4}$in wire ropes in each corner, one end of each being connected to the span or to the counterweight while the other end is connected to a drum at the machinery house on the overhead bridge. The drums are driven by a 150 h.p. electric motor which will raise or lower the span in ninety seconds. A standby motor is provided, and power is obtained from two independent lines. There is also an engine-driven generating set as an additional safeguard.

Other mechanical features include electrically operated brakes to control the span, span locks to hold it down, rail locks to ensure proper rail alignment, span and counterweight guides, air buffers, and rope take-ups. Further information about the mechanical design of the bridge is given on the inset drawing. The construction of the lifting

Table IX—*Operating Data for Lifting Bridges*

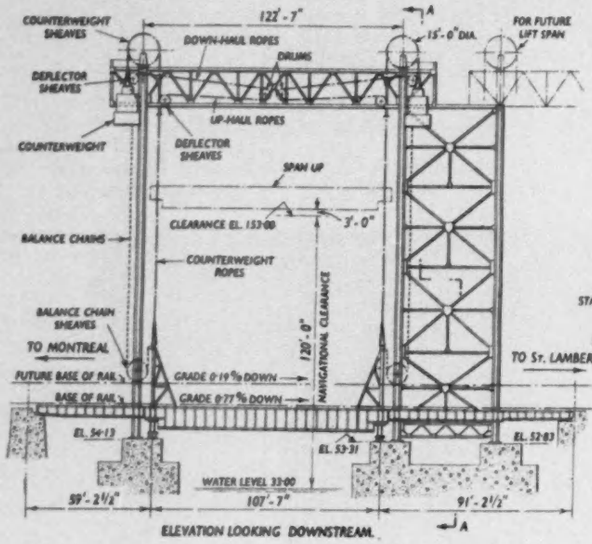
	St. Lambert downstream bridge	Caughnawaga bridge
Total operating time	90 seconds	90 seconds
Time to open bridge	75 seconds	75 seconds
Normal height of lift	96ft 2in	77ft 11in
Over-travel	3ft	3ft
Lifting sequence :		
Accelerate, zero to full speed	10 seconds	10 seconds
Hoist at full speed	55 seconds	55 seconds
Decelerate	10 seconds	10 seconds
Normal full load hoisting speed	1·48ft/secs	1·2ft/secs
Acceleration	0·148ft/sec²	0·12ft/sec²
Weights for machinery design :		
Span	1,062,400 lb	1,960,000 lb
Counterweights	1,062,400 lb	1,929,000 lb
Ropes and clamps	53,200 lb	62,000 lb
Balance chains	53,200 lb	60,000 lb
Total moving weight	2,231,200 lb	4,011,000 lb
Four sheaves and trunnions	134,800 lb	167,000 lb
Total weight for friction	2,366,000 lb	4,178,000 lb
Bridge operating against resistance of :		
Sheave friction :		
Starting	25,600 lb	56,000 lb
Running	17,750 lb	38,600 lb
Inertia	10,250 lb	14,950 lb
Rope bending	2,930 lb	5,250 lb
2½ lb per square foot vertical wind load on floor	16,000 lb	13,000 lb
2½ lb per square foot vertical ice load	16,000 lb	13,000 lb

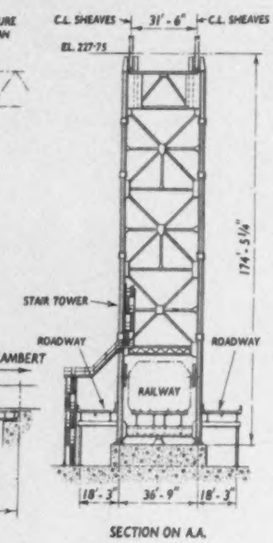
Note.—With ice load operative, the lifting time is increased, and in the case of St. Lambert Bridge, inertial resistance decreases to 6930 lb, corresponding to 0·10ft/sec² acceleration.

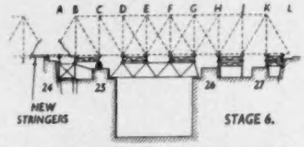
Bearing efficiencies (total) :		
Starting	0·79	0·73
Running	0·86	0·815
Gear ratio	151 to 1	160·1 to 1
Motor torque	660 lb ft	960 lb ft
Motor torque with ice load	800 lb ft	925 lb ft
Full load torque of 150 h.p., 810 r.p.m. motor	970 lb ft	970 lb ft
Brake torque required to stop bridge in ten seconds	570 lb ft	322 lb ft
Main brakes two "Thrustor" brakes, each	400 lb ft	400 lb ft
Auxiliary brakes two "Thrustor" brakes, each	3600 lb ft	800 lb ft
Power supply	550V, 3-phase, 60 c/s	550V, 3-phase, 60 c/s
Auxiliary	—	240V, 3-phase, 25 c/s
Auxiliary drive (if added)	75 h.p. at 900 r.p.m.	75kW*, 2·5 h.p. at 337 r.p.m.†
Time to open bridge with auxiliary power	4·5 minutes	166 seconds* 160 seconds†

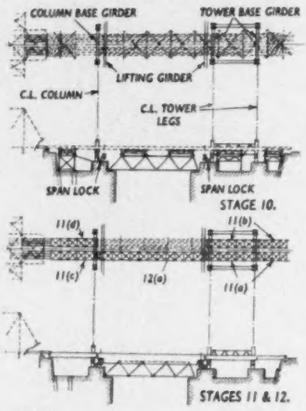
* Auxiliary electrical supply.
† Diesel engine through reduction gear.

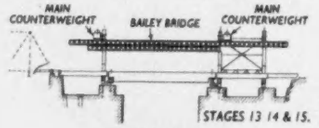
LIFTING BRIDGES ON THE ST. LAWRENCE S



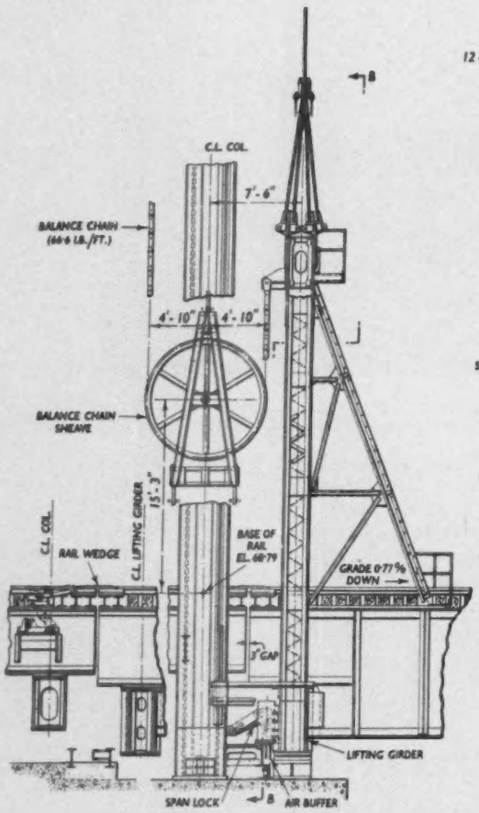




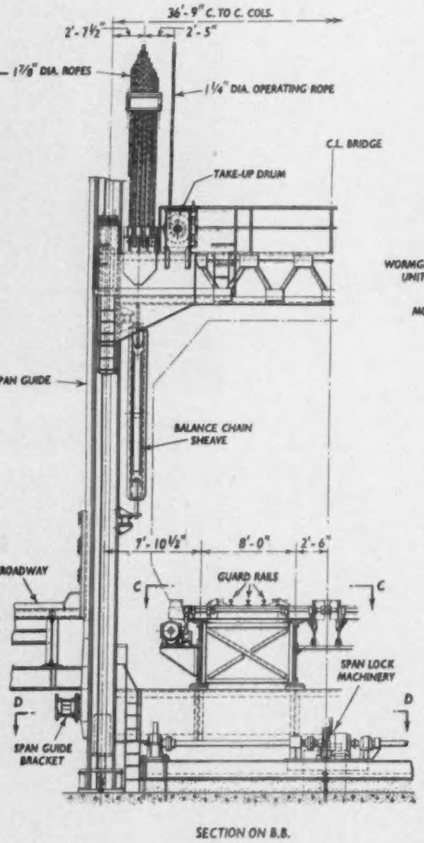




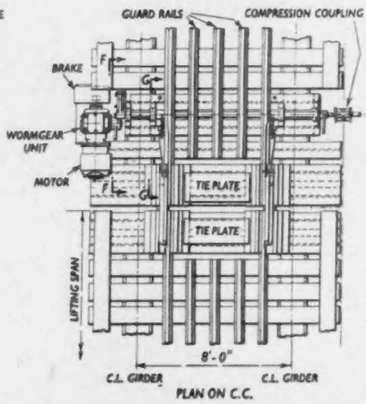
ERECTION STAGES.



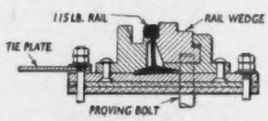
DETAILS AT END OF LIFTING SPAN.



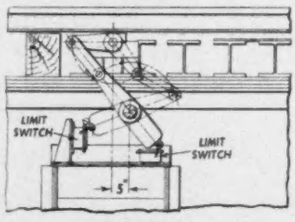
SECTION ON B.B.



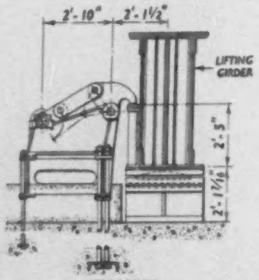
PLAN ON C.C.



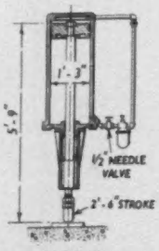
SECTION THROUGH RAIL LOCK.



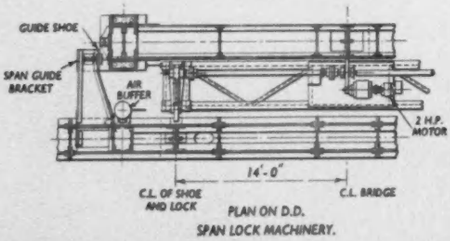
SECTION ON F.F.



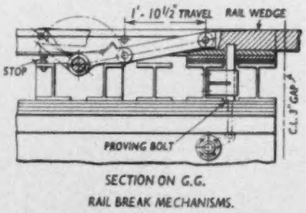
SPAN LOCK.



AIR BUFFER.



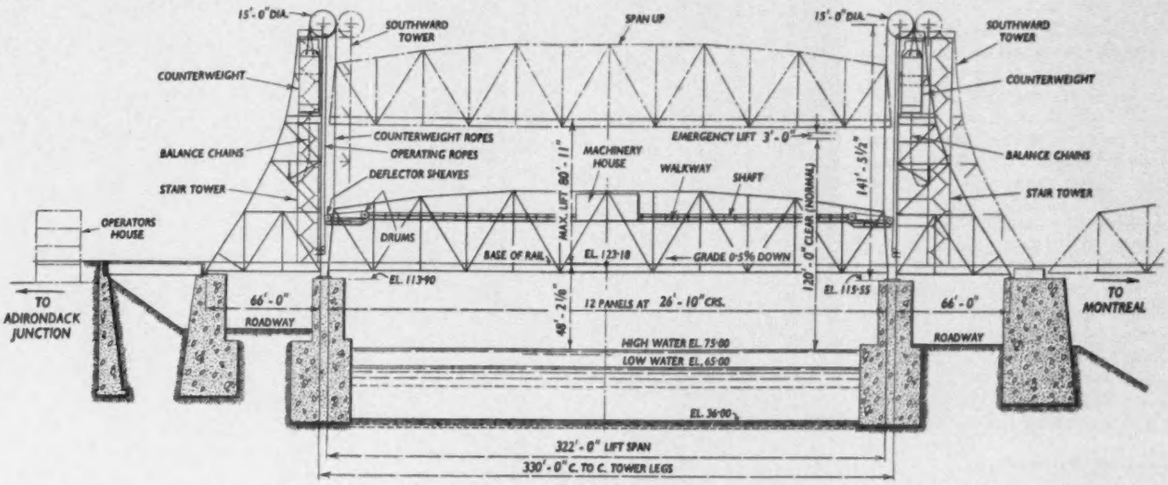
PLAN ON D.D.
SPAN LOCK MACHINERY.



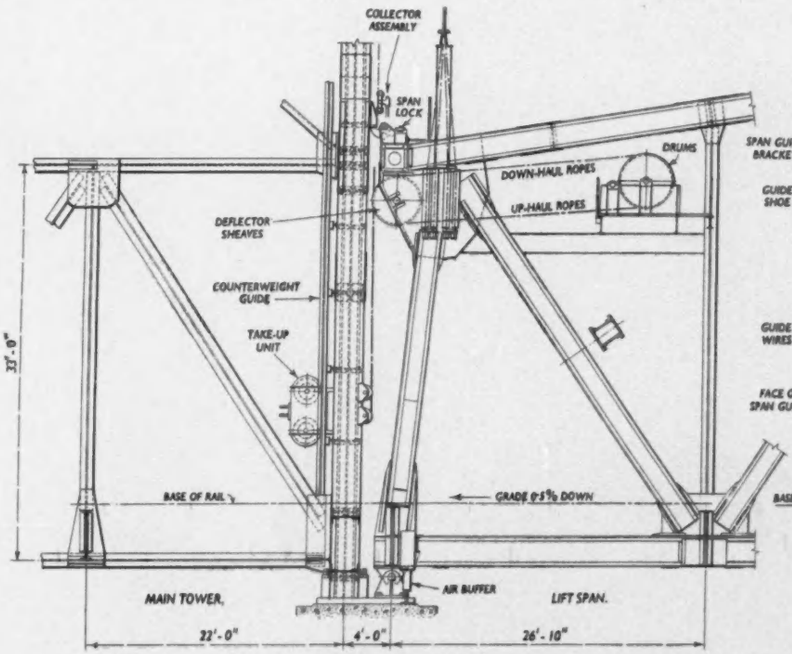
SECTION ON G.G.
RAIL BREAK MECHANISMS.

St. Lambert Downstream Bridge

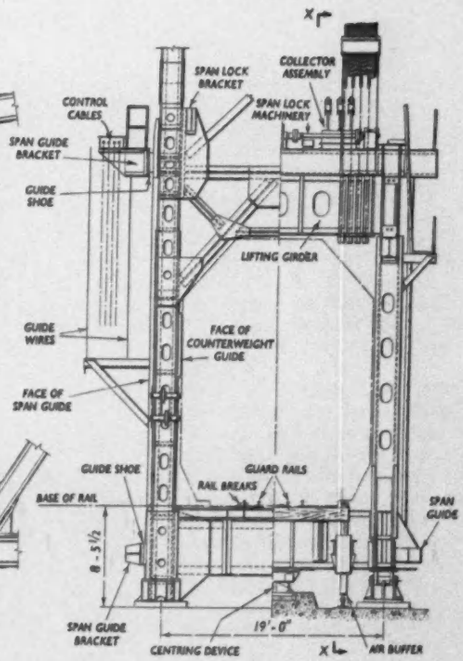
SEAWAY AT ST. LAMBERT AND CAUGHNAWAGA



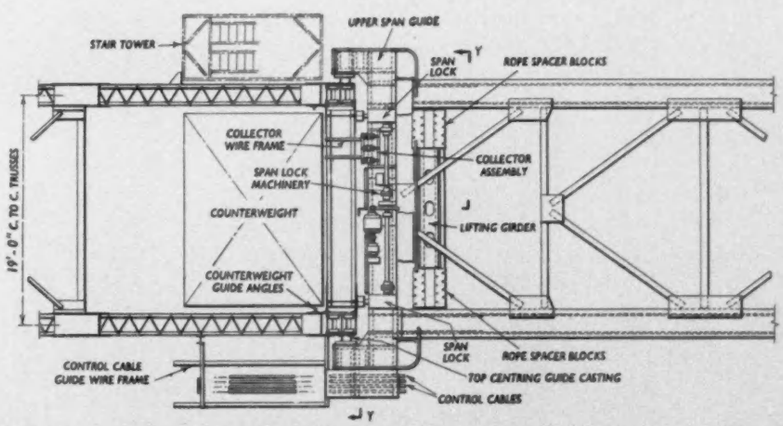
SECTION ON C.L. OF NORTHWARD TRACK.



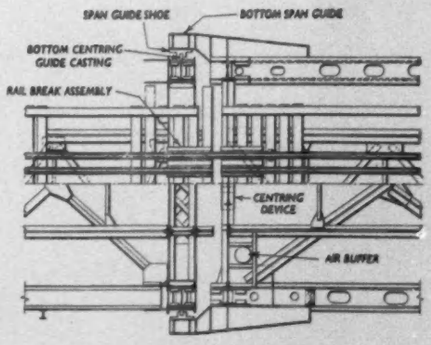
SECTION ON X.X.



SECTION ON Y.Y.



PLAN ON TOP CHORD OF LIFTING SPAN.



STEPPED PLAN AT BOTTOM CHORD OF LIFTING SPAN.

Caughnawaga North Bridge

Th

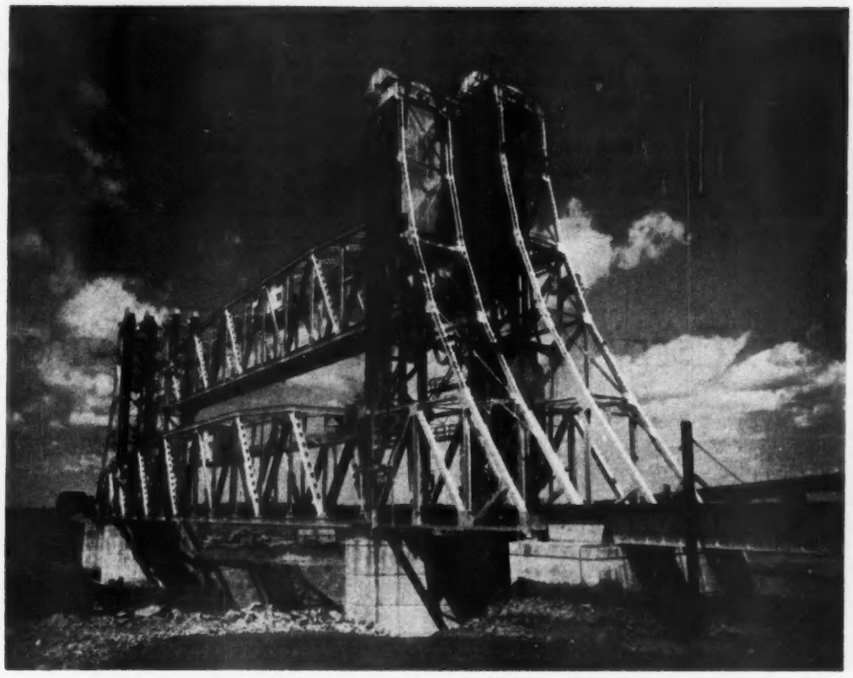


Fig. 19—Twin lifting bridges at Caughnawaga, each carrying a single rail track and spanning 322ft. Constructional details of the two bridges are exceptionally well shown in this view

span and the manner in which it is operated and guided are well shown. Other parts shown in detail are the span locks and their operating mechanism, an air buffer, and the rail-break mechanism. The latter ensures a positive check on the alignment of the rails across the fixed and lifting parts of the bridge, before the bridge is "cleared" by the signalling system.

When the bridge is lowered, and is resting on its bearings, a rail wedge (corresponding to each rail) is pushed from the fixed bridge, across the gap, to extend for about 2ft on to the lifting span. This wedge slides against the rail, on both sides of the gap, and thus ensures perfect alignment. When it is in its forward position, a proving bolt is inserted through it. The proving bolt mechanism is integrated into the signalling system. The rail wedges are driven by a 5 h.p. electric motor and reduction gearbox (shown in one of the sectional views of the assembly at the rail break) through a double system of bell-cranks; these details of the mechanism are shown.

Both the St. Lambert bridges are controlled from an operator's house near the centre of the lock from which the lock gates and valves are also controlled. A system of interlocked limit switches ensures that railway signals, highway warning sirens and gates, and the bridge machinery can be operated only in the proper sequence. The bridge control circuit starts and stops the span automatically at the proper level when raising or lowering. Further details are given in Table IX.

Erection of St. Lambert Bridge

The inset drawing also shows four major stages in the erection of the bridge. As already explained, road traffic had been diverted for erection, but the railway remained in use, though it was possible to allow a certain amount of single-line working, and hence to replace the structures corresponding to each line successively, and the design took advantage of this by considering the bridge largely as two "tracks" side by side. Erection was based on the use of a very large guy derrick, the construction of which was itself no mean feat. This derrick had a capacity of 150 tons, a 202ft mast and a 160ft boom. It was mounted on a 182ft steel tower standing on the floor of the lock. The top of the derrick mast was thus 384ft above the lock floor or 323ft above the top of the lock wall. Falsework designed to support both the live and dead loads of the existing structure was then erected under the existing bridge, consisting of 94ft steel trusses spanning the lock, and of steel columns and bracing elsewhere. The weight of the existing span was transferred to the falsework by wedges, and the trusses and overhead bracing then dismantled. The existing railway bridge floor was then removed in sections under one track at a time and replaced immediately by new railway girders and deck, pre-assembled in large units. When the towers were erected to a point above the railway clearance line, temporary Bailey bridging was installed over the track. A timber mat 36ft wide and 12in thick laid over the Bailey bridging protected passing trains from the operations above, allowing erection of the upper portions of the towers, overhead bridge, counterweights and machinery.

Since the erection of this bridge presented such difficulty, it is worth following through the work in a little more detail, according to its numbered stages as follows.

Stage 1 involved completion of the new piers numbered 25, 26 and 27 in the drawing, with the construction of St. Lambert lock in this area. The road by-passes were constructed at this stage, road traffic was diverted, and power and telephone services removed.

Stage 2.—Certain revisions to the masonry of Victoria bridge were then carried out.

Stages 3 *and* 4.—The large derrick was erected.

Stage 5.—The cantilever roadways were removed from the old bridge.

Stage 6 is the stage illustrated in the first of the erection drawings on the inset plate. The steel falsework trusses were erected, with about 2in of clearance between the falsework and the old steelwork to permit truss deflections. And the rivets of the floor system were replaced by bolts and the timber blocking at "C" and pier 24 was erected. Longitudinally, there were three bents of falsework, positioned to allow work to proceed at either track.

Stage 7.—New stringers were erected in span 24.

Stage 8.—The load was transferred to the falsework. This operation involved stopping traffic on both tracks (the maximum allowable period was three hours). First wedges were driven in, against shims previously placed beneath the deck of the old bridge. The wedges were driven "snug," except for the centre wedges at the panel points *B*, *H*, *J* and *K*, where they were driven slightly beyond the "snug" position. Wedges and shims were tack welded. At position *C*, timber wedges were used. The bottom chord of each truss was then cut between *E* and *F*. Turnbuckles in the four centre panels were then slackened. At this stage the falsework was carrying the load, and railway traffic was resumed on both tracks. The operation was completed with further welding, bolting and floor bracing, and the bottom chord of the old truss was cut between *C* and *D*, *G* and *H*, and *J* and *K*.

Stage 9 consisted of dismantling the old trusses.

Stage 10 is shown in the second diagram of the sequence in which the first tier of the lifting bridge towers, the base girders, span locks and four lifting girders were erected. Single-track working was needed at this stage during replacement of the timber blocking at position *C*. The floor beam of the old bridge was carried on this blocking at the beginning of the operation. Rearrangement of stringers and shear connections was necessary prior to the replacement of the timberwork and old steel floor beam by the base girder and base section of the lifting bridge. Packing was then placed above the new base girder, and the position *C* load transferred to it. Finally, the span lock and lifting girder at this position were constructed, and held in their correct relative positions by a temporary stiffening diaphragm.

Stage 11 consisted of five operations: (*a*) erect tower span and south approach span (of 24 tons and 11 tons weight respectively) on upstream side, (*b*) the same operation on the downstream side, (*c*) erect north approach spans on the upstream side, (*d*) the same operation on the downstream side. These four spans are labelled respectively (*a*)–(*d*) in the third diagram. And (*e*) remove falsework bents under the approach spans. Each of these spans was assembled and riveted close to its ultimate position and then lifted into place.

Stage 12.—Construction of railway lift span, in two stages, the upstream and downstream sides respectively, and dismantling of the last falsework. This is the stage shown in the third diagram. Each half of the lift span weighed 100 tons, and was again assembled and riveted close to its final position, and then lifted into place.

Stages 13, 14 *and* 15, as shown in the fourth diagram, involved erecting the second tier of the lifting bridge towers, then building on them the Bailey bridge with its protective timber mats, and finally erecting the main counterweight boxes on the Bailey bridging. Again, two-stage erection with corresponding single-line working was adopted for the Bailey bridge erection.

Stages 16 *to* 20.—The remaining work involved the straightforward erection of the remainder of the bridge; the installation of the machinery; erection of the highway cantilever spans; raising and filling the counterweight boxes; removal of the Bailey

bridge and mat ; and completion of erection and machinery installation.

At only one time—for three hours at load transfer (stage 8)—was rail traffic stopped on both tracks. There were twenty-four periods when traffic was restricted to one track, all of them of six hours' duration or less, except for the placing of the two sections of the lifting span ; one track was closed for forty-eight hours for each of these operations.

Caughnawaga Lifting Bridges

Two independent lifting bridges, one for each track, have been built side by side in way of the C.P.R. line at Caughnawaga to give the clearance of 120ft over Seaway channel. The two bridges are shown in Fig. 19 ; they are identical except for secondary details, such as stairs and walkways. Typical details are shown in the inset drawing.

Each bridge consists of a 322ft lifting span —a " camel-back " truss of twelve panels with a centre depth of 48ft—at each end of which is a tower having an overall height of 140ft 6in above the base of rail. The lower portion of each tower forms a 66ft truss span. Leading to the towers, at each end of the bridge, there is a 55ft " deck " plate girder span. The overall length of each bridge is 595ft.

The bridges were designed for Cooper's E70 railway loading, and conform to Canadian Standards Association specifications. They are rope operated, the operating machinery being housed at the centre of the lifting span, with the exception of the operating rope drums which are in the end panels. The span is driven by either one of two 150 h.p. motors. An auxiliary engine-driven generator is also provided for emergency operation. Both lift spans are operated from a control house on the railway embankment south of the bridges.

At each end of the lift span, connecting it to the counterweights, there are thirty-two wire ropes 1⅞in in diameter. These ropes pass over two sheaves 15ft in diameter at the top of each tower. The counterweight consists of a reinforced-steel-plate box filled with concrete. Space is provided at the top of the box for concrete balance blocks.

The weight of the lifting span complete with decking is 988 tons. Including fifteen seconds operating time for the signals and span locks, the bridge is raised 77ft 11in in ninety seconds. The hoisting speed is 1·2ft per second.

In general, two methods of erection were used for the bridge. The lifting span was erected on 80ft high timber falsework bents by a locomotive crane. The towers, however, were erected with guy derricks, with a 20-ton derrick seated on a 90ft high erection tower, at each end of the bridge. Thus erection of the towers proceeded simultaneously with that of the lift span. The derricks were, in fact, those used to erect the upstream bridge at St. Lambert lock.

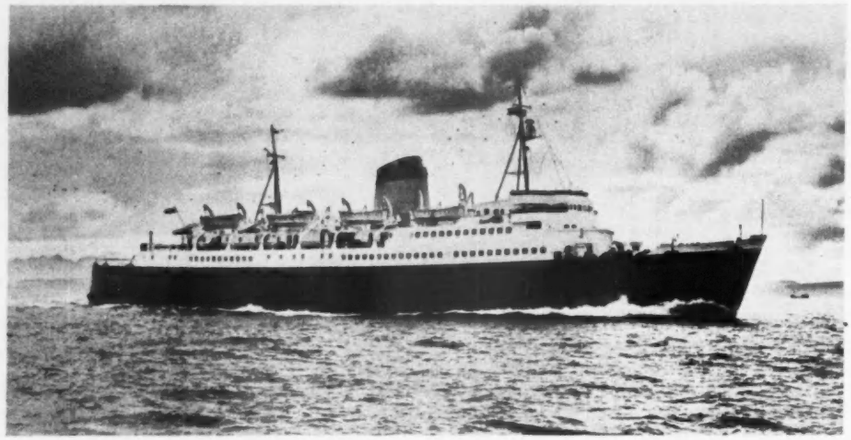
The railway was at that time approximately 100ft to the west of the bridges and very nearly parallel to them, on a 50ft high embankment, the toe of which extended underneath the west bridge. Prior to erection of the bridges, however, the channel was excavated to the centre line of the west bridge, leaving the embankment relatively undisturbed. Due to the difficulty of placing falsework under the west lifting span, falsework was erected on the centre line of the east bridge only. The west span was erected on this falsework and then translated horizontally a distance of 32ft, using roller trucks and hydraulic jacks. Erection of the east span then proceeded on the same falsework. The bridges were completed in the spring of 1958. Gradients on the approach tracks were eased from 0·75 to 0·50 per cent when the lifting bridges were built. This work involved 1½ miles of line, and a maximum increase of track level of 10ft.

The Victoria bridge is owned by Canadian National Railways, and the design of the two lifting bridges at St. Lambert lock was undertaken jointly by the C.N.R. and by the St. Lawrence Seaway Authority. The two lifting bridges at Caughnawaga are on the Canadian Pacific Railway Company's line, and, again, design was the joint responsibility of that organisation and of the Seaway Authority. All four bridges were built by the same contracting firm, namely, the Dominion Bridge Company, Ltd., to whom we are indebted for the original drawings which have been reproduced in the folding inset.

(To be continued)

Car Ferry for Continental Services

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.



The rapid increase in the number of people wishing to take cars abroad has led to the building in recent years of a number of new car ferry ships. The s.s. " Maid of Kent " entered service between Dover and Boulogne on May 28. She was built by William Denny and Brothers, Ltd. She has a gross tonnage of 4413 and can carry 180 motor-cars and 30 motor-cycles and 1000 passengers.

As the number of cars to be carried between Britain and the Continent increases, so does the need for additional tonnage grow. It now is a far cry from 1931, when the first steamer specifically built for this service, the " Autocarrier," was built, to that of the present day. The cross-Channel passenger steamer " Dinard " was converted to a car ferry capable of taking seventy cars and 400 passengers. A new phase in the development of this class of vessel took place when the " Lord Warden," a modern vessel embodying many new ideas came from the yard of William Denny and Brothers, Dumbarton, in 1952 ; she has already been described in these pages.* After her came the Belgian car ferry " Artevelde,"† followed by the French " Compiegne,"‡ both motor vessels and both coming into service in 1958.

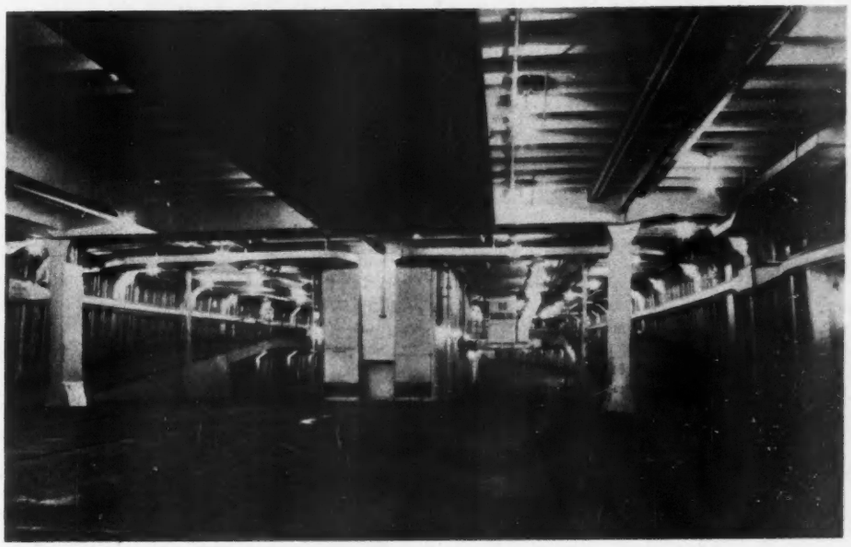
A need was experienced for still further craft to cope with increasing demands, with a result that the British Transport Commission ordered a vessel from William Denny and Brothers, Ltd., " Maid of Kent " being launched at Dumbarton on the 27th of last November. She is bigger than " Lord Warden," having the following principal dimensions : length overall 373ft, between perpendiculars 348ft, on waterline 358ft ; breadth moulded to main deck, 59ft ; depth moulded to main deck, 18ft 3in ; draught loaded, 13ft ; deadweight, 850 tons ; tonnage, 4413 gross, 1983 net. For the sake of comparison it might be mentioned that the " Lord Warden " has a length overall of 361ft ; a breadth moulded of 59ft ; a depth to main deck of 17ft 9in ; and a tonnage of 3333 gross. The new vessel can carry 180 cars and thirty motor-cycles as against the 120 of her sister, and she can also take 1000 passengers and a crew of ninety-six. As will be seen from the illustration the " Maid of Kent " has a pleasing appearance with her raked stem cruiser stern, two tripod masts, and single funnel of modern lines. Among the new features that are incorporated in her are her two car decks, a bow lateral thrust unit, twin rudders, power-operated turntable on the car deck, glass fibre lifeboats, and a single hinging up power-operated stern door, and a flying bridge.

The general layout of decks working from the top downwards is as follows : on the bridge deck are the wheelhouse and chart room, and the captain's and navigating officers' accommodation, the captain being given a large self-contained suite consisting of day room, bedroom, lavatory and bath room. On the boat deck is a smoke room and bar, and also cabins for the engineer officers, direct access to the engine-room being provided. There is liberal seating on the open part of this deck. On the promenade deck forward is a spacious lounge and buffet, in two sections consisting of port and starboard corridors amidships leading into the lounge proper forward, which extends the full width of the ship. The

* The Engineer, June 27, 1952, page 853.
† The Engineer, July 18, 1958, page 98.
‡ The Engineer, August 22, 1958, page 293.

seats along the sides, protected by large glass windows, are fitted with headrests and are covered with olive green leather. Opening off the main lounge is a ladies' rest room, and passport and ticket offices. Aft of the lounge is the main entrance, opening off which are four passenger cabins, a shop, bureau de change, and A.A. and R.A.C. offices. Astern of this is the restaurant extending the full width of the vessel and accommodating 168 persons at a sitting. The chief steward and pursers have cabins adjacent to the restaurant, while immediately abaft it are the galleys, pantry, &c. The main deck, which is the length of the ship, is devoted to the accommodation of cars, and above it is a mezzanine deck to which access is obtained by means of ramps, this deck extending from forwards to amidships, leaving a clear deck height of 11ft at the aft end available for coaches and caravans. The single stern door fitted between main and promenade decks, hinges upwards and outwards, and is power-operated by an electrically-driven winch supplied by Thomas Reid and Sons. Two turntables are provided on the main deck. The one at the aft end is 22ft in diameter and power-operated, being suitable for vehicles weighing up to 24 tons. Round sidelights are fitted in the ship side throughout the motor vehicle spaces. The vessel is subdivided by eleven watertight bulkheads, electrically-operated horizontal sliding watertight doors being fitted to the bulkheads in the machinery spaces.

The main machinery comprises two sets of latest Pametrada design geared turbines, manufactured by the builders, the total output of which is 11,500 s.h.p. at 270 propeller revolutions per minute. Each set consists of a single-casing turbine of all-impulse type, driving the associated propeller shafting through a locked-train articulated, double-reduction gearing imparting to the vessel a speed of 20¾ knots. The all-impulse astern turbines are incorporated in the same casing as the ahead turbines, and give a speed astern of 15 knots. The main engine manœuvring valves are of Cockburn (Cardonald) patent, as are the emergency shut-off, governing and cross-connection valves. The manœuvring valves, which are of super-balanced type, have separate hand wheel control for ahead and astern valves. The emergency valves are arranged to close automatically in the event of low vacuum conditions and can also be operated by hand lever control from the starting platform,

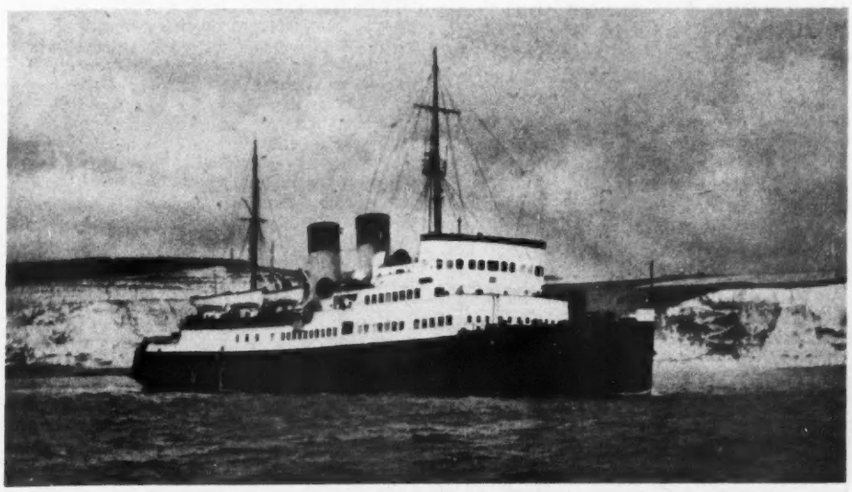


The main car deck has ramps leading to the mezzanine car deck. Besides cars, coaches and caravans can be accommodated

while the governing valves are arranged to close automatically in the event of overspeed, undue axial clearance or loss of lubricating oil pressure. This arrangement of emergency "shut-off" is designed to allow steam to be available to bring the turbine quickly to rest in the event of loss of lubricating oil pressure. The main thrust blocks, of the "Michell" pivot type, are incorporated in the gear cases. The main shafting bearings are of Cooper split roller type. The tail shafts run in white-metal-lined stern tubes, lubrication being on the Vista-Neox oil feed system. The stern gland packing is of the United States type. Vickers patent oil sealing glands are fitted at the outboard end of the stern tubes. The propellers are four-bladed, of Holiston design in "Novoston alloy," and have a diameter of 9ft 8in. Electric motor-driven turning gear is fitted to the main engines. Steam for main and auxiliary purposes is supplied by two Babcock and Wilcox integral furnace type oil-fired boilers, at 350 lb per square inch pressure and 650 deg. Fah. at the superheater outlet. Each boiler has a normal evaporation of 55,000 lb per hour, a furnace volume of 512 cubic feet, a tube heating surface of 4776 square feet, and a superheater heating surface of 250 square feet. Forced draught is on a confined duct system. The oil-burning equipment for the main boilers consists of one unit comprising two electrically-driven pumps, each of a capacity of 10,000 lb per hour, three steam heaters and suction and discharge strainers. The lighting up unit comprises one Mirrlees "Imo" type pump, electric heater and discharge filter. The oil-burning equipment is designed to burn boiler oil of 3500 seconds viscosity. To enable this class of oil to be dealt with effectively electric heating cables of "Isotape" type are fitted to the suction ranges between bunkers and pumps. For the same reason, in addition to the normal bunker heating coils, combined steam-electric immersion heaters of "Dunlow" type are fitted in way of suction ends in the bunkers. The air supply to the boilers is provided by two W. H. Allen turbo fans, each capable of delivering 22,000 cubic feet of air per minute against 10½in W.G. Two independent electric motor-driven fans each provide 3000 cubic feet per minute when lighting up. Scott blowers for the boilers are of Babcock and Wilcox make, and each boiler has two Klinger double-plate and one "Igema" distant-reading water-level indicator.

For domestic steam supply a Spanner "Swirlyflow" boiler working at a pressure of 60 lb per square inch is installed. The fully automatic oil fuel pumping and heating unit for this boiler is designed to deal with 3500 seconds viscosity oil, and comprises one l.p. pump of Mirrlees make and one h.p. "Deri-Sine" pump of Andrew Fraser make, electric heater and suction and discharge strainers. The burner is of air-assisted, turbo-jet type, complete with rotary converter, independent forced draught fan, and electronic controls. All domestic heating steam exhausts pass to a drain cooler of Denny make, and an automatically controlled Weir pump is provided for domestic boiler feed water duties.

The main condensers are of Pametrada regenerative design and of Denny make. Each has over 2000 aluminium brass tubes, ¾in external diameter, giving a cooling surface of 3500 square feet. The tubes are packed with "Crane" metallic packing. The condensers work in conjunction with a Weir closed-circuit feed and deaerating system, which includes two closed-feed controllers; two motor-driven, two-stage centrifugal extraction pumps; two three-stage air ejectors, with intercoolers; one "Optimum"



The S.S. "Dinard," originally purely passenger-carrying, was converted between the wars for ferrying cars across the Channel

type deaerator complete with devaporiser, and one deaerator extraction pump discharging to the main feed pumps. The feed water leaves the deaerator with an oxygen content of 0·02 cubic centimetre per litre, and at a temperature about 220 deg. Fah., no other feed heating being required. The exhaust steam supply from the turbo-driven auxiliaries to the deaerator is controlled by a British Arca Regulators, Ltd., air-operated diaphragm type valve. The pressure in the auxiliary exhaust range is regulated by means of "Sunvic" control gear supplied by G. and J. Weir, Ltd., by means of which any excess pressure is automatically passed to the condensers by an exhaust rejection valve, while a drop in pressure is made good from the main steam range by a make-up valve. The air supply for the "Sunvic" and "Arca" equipment is provided by an electrically-driven air compressor of Broom and Wade make. An emergency supply is arranged for the generators starting air range. The two Weir turbo-driven main feed pumps are of horizontal-spindle, centrifugal, two-stage type, each 110,000/147,000 lb per hour capacity. An electrically driven, three-throw, reciprocating type pump of Weir make is provided for harbour use. Weir "Robot" feed-water regulators are fitted to the main boilers. The main Drysdale circulating pumps, having a bore of 18in, are of upright type, and, are turbo-driven, each delivering 6000 gallons per minute.

Electric current for lighting and power at 225V d.c. is provided by four 300kW W. H. Allen diesel generators. The engines are seven-cylinder airless injection type, each having its own independent lubricating oil and fresh water pumps and coolers. Two electrically-driven salt-water circulating pumps, also of Allen make, each having a capacity of 17,000 gallons per hour, supply cooling water for the heat exchangers. For generator starting purposes, four air receivers, each with an 11·2 cubic feet capacity, are fitted, the air being supplied by one diesel-driven and one motor-driven air compressor of Hamworthy make. The main switchboard, 25ft long and 6ft 6in high, is at the aft end of the engine-room. A 225V d.c., 50kW Allen generator, driven by a six-cylinder Ruston and Hornsby diesel engine, is fitted on the boat deck to supply power for emergency purposes. An emergency battery of 140Ah capacity is also housed on the boat deck. This is connected to the emergency lighting and water-tight door circuits and is arranged to come into operation automatically in case of failure of the main or emergency source of power. A low power supply at 25V d.c. for clocks, telephones, alarm bells, &c., is provided by a motor-driven generator and a storage battery, while two motor alternators supply power for the fluorescent lighting in public rooms. The motor-driven lubricating oil pumps, two in number, for the main engines are capable of each delivering 19,000 gallons per hour at 40 lb per square inch, sufficient for the full requirements of both engines at full power. Serck vertical type oil coolers, Auto Klean discharge strainers, and Philips magnetic suction filters and wire mesh strainers are fitted. The lubricating oil purifier is Sharples super-centrifugal type of 200 gallons per hour capacity. An electric heater is fitted for use in conjunction with the purifier. Two Worthington-Simpson vertical "Numarine" self-priming pumps are installed for bilge, ballast, fire, wash deck and emergency condenser circulating duties. Each is driven by a 13 h.p. electric motor and is of 75 tons per hour capacity.

Among other auxiliary plant may be mentioned: an emergency bilge pump, an evaporator and a distiller, each of a capacity of 30 tons per hour, to produce make-up feed for the boilers, a "Victor" automatically operated oily bilge water separator, an oily bilge water transfer pump, a motor-driven pump for transferring diesel oil from main bunker to the generator service tanks, two Swedish made "Supertyfon" steam whistles, one having electric control, and a Crockett group type electric salinity indicator.

The ventilation of the machinery spaces was designed in conjunction with Thermotank, Ltd.; two reversible fans supply air to the engine-room and two non-reversible to the boiler-room, all of 30,000 cubic feet per minute capacity.

Fuel is carried in five tanks situated forward of the boiler-room, four of the tanks being fitted for furnace oil and one for diesel oil for the diesel-engined electric generators. Double bottom ballast tanks are provided, and fresh water and feed water tanks are placed below the lower deck at the sides aft of the engine-room, and four storage tanks for distilled water are at the aft end of the boiler-room. Hatchways in the promenade deck forward and aft permit crane handling of vehicles if necessary. Deck machinery is electrically driven and consists of a windlass and capstan forward and two capstans aft.

Deck lounge; The ship can carry 1000 passengers

There are eight lifeboats, two being motor-driven and six fitted with "Fleming" type hand-propelled gear. These lifeboats are of glass fibre reinforced construction. There are also twenty-six inflatable life rafts for twenty-six persons each.

The mechanical heating and ventilating system for passenger and crew accommodation is by Thermotank, Ltd.; electric heaters are also fitted in officers' and crew's quarters. Ventilation trunking has been arranged within vertical fireproof zones with air heaters, fans, &c., fitted on the bridge and boat decks. Accommodation spaces generally are provided with independent temperature control of the air supply by means of regulating valves. The ventilation of the motor-car decks has received special consideration with supply fans delivering air overhead and exhaust fans extracting air through trunking led down to deck level, inboard and outboard, thus ensuring efficient removal of exhaust fumes.

Special attention has been paid to fire prevention, and fireproof materials have been used wherever possible. In addition to the usual fireproof bulkheads and doors, fire hydrants, foam and chemical extinguishers and manual alarms, an automatic sprinkler and fire alarm system has been installed throughout the vessel. A water spray curtain system supplied from independent pumps divides the main and mezzanine decks into fireproof zones, while Pyrene foam-making machines, are available for use in these spaces if required. A "Mulsispray" fire-extinguishing system is in the boiler and engine-rooms.

Steering gear for the bow rudder and the twin main rudders of electro-hydraulic type have been supplied by Brown Bros., of Edinburgh, as also are the Denny Brown stabilisers, and the bow lateral thrust unit, which is in the form of an electrically-driven cycloidal propeller of Voith Schneider design, fitted about 36ft from the bows and capable of giving a side thrust of 4 tons. The driving motor for this propeller is 400 b.h.p., of W. H. Allen make. This unit will be used to assist manœuvring at low speeds to thrust the ship's head towards or away from the quay, and to assist in holding it up to wind when manœuvring or berthing.

In the wheelhouse are found all modern aids to navigation, including Marconi direction finding equipment and Radiolocator marine radar, Fathometer echo sounder, Chernikeeff electric log repeater, Typhon automatic whistle control, Smith's Instrument Company lateral thrust unit and revolution indicators, Siemens helm indicator, and engine, docking and steering telegraphs, Clifford and Snell loud-speaking telephones to engine-room and mooring positions, and a main and emergency wireless installation with radio-telephone facilities. Kent clear view screens are provided on port and starboard sides of the windows facing forwards.

An inaugural crossing from Dover to Boulogne was made on May 27, during which the effect of the stabilisers was demonstrated by imparting to the vessel an artificial roll by reversing the stabilisers, and then eliminating the roll by the use of the stabiliser. The "Maid of Kent" made her maiden voyage next day, and then went into regular service.

Corrosion Engineers' Association

AT a luncheon given under the auspices of *The Corrosion Engineer* at the Rembrandt Hotel, South Kensington, on May 29, 1959, Mr. H. M. Powell, who is technical director of Cathodic Corrosion Control, Ltd., and chief electrical engineer of the Constructors John Brown organisation, announced the formation of the British Association of Corrosion Engineers. The objects of the Association will be generally to promote the dissemination of technical information about corrosion matters and to develop by means of social activities the free interchange of information among members. In due course the Association, which is, of course, essentially non-profit making, will progress towards the establishment and acceptance of suitable qualifications for corrosion engineers, and the promotion of standardisation in the terminology and techniques of corrosion control. When the Association is in full operation it is intended to hold full-scale meetings with papers, films and discussions, which should be of great benefit to the corrosion engineering profession as a whole and which will promote and foster its growth and development as well as being of general service to industry. Full details and membership application forms can be obtained from the hon. secretary, British Association of Corrosion Engineers, 97, Old Brompton Road, London, S.W.7.

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FREEING AN END OF A NEW MOTORWAY

SIR,—Recently, Mr. Watkinson put out that his Ministry would be glad to have suggestions " from any source " for preventing the time saved on the new motorways being frittered away in the towns and cities at their ends. Traffic engineering is in the news, and the following memo. may be described as an essay in the " art of the possible," rather than a dream of the future.

The writer has been considering what is going to happen to the traffic on the Ross Spur motorway when it is let loose on to the existing road system at the western end. It is clear that something like 70 per cent will be funnelled on to the Ross–Monmouth section of A40. Just before Abergavenny, approximately half will turn left to Pontypool and Newport and so to industrial East South Wales, while the other half will pass on to the " Heads of the Valleys Road " to Merthyr and thence to Cardiff and Swansea. Pembrokeshire traffic, which is likely to increase rapidly, will, of course, continue on A40. Thus we have bottlenecks at Monmouth, Abergavenny, Merthyr and Brecon. The worst situation will occur on the Ross–Monmouth section and in Monmouth itself, as all the motorway traffic will be added to the heavy London and West of England traffic on the Gloucester–Ross section of A40.

The British Transport Commission has closed completely the Monmouth–Usk–Pontypool line. Passenger services have ceased completely at Monmouth, and half the Ross–Monmouth line has also been completely closed. Moreover, the double track line from Abergavenny to Merthyr has also been closed, which runs parallel to the " Heads of the Valleys Road." Fascinating possibilities are opened up by this situation if only there was co-operation between the roads department of the Ministry, on one hand, and the B.T.C., on the other. We have been told that we should have dual carriageways where possible, where traffic is heavy and the essence of the schemes proposed in this memorandum is the use of these disused or nearly disused railways as " half a dual carriageway " with limited access. There is little doubt that an overloaded trunk road like the Ross–Monmouth section, which is only two carriageways in width and has steep hills and many blind turns on it, would be far more adequate if all long-distance traffic in one direction was able to use a parallel route. The parallel route, built on the old railway formation, need not be more than 20ft wide, provided there are adequate lay-bys and the short sections through tunnels and over long bridges, very few in number, would be perfectly adequate if reduced to 12ft. In fact, the existing road at the bottlenecks is reduced to something like this with the added difficulty of lorries unloading at shops without service roads at their rear. The fact that the new road does not remain close to its companion is a positive advantage as there is no possibility of headlight glare. Moreover, this road would pass through the towns *en route* acting as " half a by-pass." Some new " Freeways " in the U.S.A. are, it is believed, being designed where one carriageway wanders from its companion. Very short lengths of new, narrow and, therefore, cheap single-lane roads would be required at various points to provide access to the railway formation and therefore the amount of compulsory purchase of land would be negligible. The results in improved traffic flow in relation to the expense involved would be far and away greater than any other possible solution.

What is actually happening is that local authorities are requisitioning historic buildings in their towns to improve, slightly, the bottlenecks, and the B.T.C. are tearing up the bridges on their abandoned formations, which could be very cheaply adapted as road bridges, with the apparent object of making it more difficult to convert them into roads ! The recovery value of the old metal bridges must be very small after demolition costs, and the fact that the B.T.C. can proceed to demolish these before consideration of the use of the formation as a road is little short of a scandal in the writer's opinion. Incidentally, most, if not all, the bridges on the Monmouth–Usk–Pontypool single line were built for double track and, therefore, would be quite adequate in width. Detailed plans for " all but " curing the bottlenecks in the towns of Monmouth, Abergavenny, Merthyr and Brecon cannot be gone into here, but the writer is convinced that they are practical and would cost a fraction of conventional by-passes.

When Earl Howe raised the question of the use of abandoned railways as roads in the House of Lords recently he got the answer that the Ministry is powerless to act unless the local authorities concerned take the initiative first, which seems to be a pretty lame answer. One of the surprising facts revealed during the writer's investigations is that local authorities have a completely " could not care less " attitude towards congestion in their towns and local traders cannot be convinced that they will not lose trade if traffic flow is eased. Local road surveyors' chief concern seems to be to avoid any further road mileage to look after as they consider themselves overworked as it is !

D. F. C. VOSPER

Llandovery,
Carmarthenshire,
June 12, 1959.

Book Reviews

Theorie und Berechnung der Stahlbrücken. By A. HAWRANEK and O. STEINHARDT. Springer - Verlag, Berlin - Wilmersdorf, Heidelberger Platz 3. Berlin-Göttingen-Heidelberg. Price : DM.66

SINCE the publication of Professor Hawranek's book in 1943, substantial practical and theoretical progress in the design of steel bridges has been made, thus amply justifying a completely revised version of the earlier work. After reviewing the basis of bridge structures in the theories of structures and of elasticity, Professor Steinhardt discusses the behaviour of plates, in particular isotropic and orthotropic plates, and the properties of modern deck structures. A further theoretical chapter is devoted to the buckling of struts and plates, after which the author proceeds to a full discussion of deck designs (orthotropic plates and reinforced concrete decks). These sections are followed by chapters on plate and lattice girder bridges, arch bridges and suspension bridges, including their dynamical behaviour, and model tests designed to check aero-dynamical stability. Finally, the author reviews the development of compound structures of steel and concrete.

Obituary

A. TREVE HOLMAN

WE have learned with regret of the death of Mr. Arthur Treve Holman which occurred suddenly, in Lisbon, on June 6. He was sixty-six. Mr. Holman, whose home was at Chyverton, near Truro, was chairman of Holman Brothers, Ltd., the family firm with which he had been closely associated for fifty years. He had gone to Portugal to convalesce after a recent illness and to visit the British Trade Fair. Mr. Holman was the eldest son of the late Mr. John H. Holman, of Camborne. He was educated at Blundell's School, Tiverton, and at Birmingham University and served his apprenticeship in the Holman works at Camborne, which were started in 1801 by his great grandfather. He became a director of the company in 1914 and in 1949 was appointed chairman and joint managing director. Mr. Holman relinquished this latter appointment, however, last October on account of indifferent health.

Mr. Holman's half-century of service with his firm was outstanding. He made many valuable contributions to the development of compressed air and mining equipment and to the solution of problems associated with silicosis and industrial dust diseases. Moreover, during his extensive travels overseas he was a worthy ambassador not only for his own company but for the British engineering industry generally. There were many other ways in which Mr. Holman's work was distinguished. He was intensely proud to be a Cornishman. The establishment of the notable Holman Museum at Camborne bears testimony to that as also does his enthusiasm for the Cornish Engines Preservation Society, which he helped to found and of which he was the chairman. Then, too, Mr. Holman was actively concerned in the improvement of technical education, especially in the Camborne-Redruth area. His public service included a term as High Sheriff of Cornwall, membership of the governing body of the Camborne School of Mines and membership of the Cornwall Coastal Advisory Committee. Mr. Holman was a member of the Institution of Mechanical Engineers and the Institution of Production Engineers and of the Newcomen Society. In association with this Society, he took a prominent part in the erection of the Trevithick statue at Camborne and the restoration of Trevithick's cottage at Penponds.

Cobalt Container for Industrial Radiography

A COBALT container with a source of 1500 curies, believed to be the most powerful in industrial use in the world, has recently been supplied by Newton Victor, Ltd., the X-ray department of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. After being fitted with its cobalt-60 source at the U.K. Atomic Energy Research Establishment, Harwell, the container was transported by road to the Darlington Factory of Whessoe, Ltd. There it was installed in a specially constructed concrete building and it is being used for the radiographic examination of welded seams in steel plate (up to 5in thick), as illustrated here.

The cobalt source is housed in a lead and heavy alloy protective container thick enough to reduce the intensity of the radiation at the surface to 6·25 milli-röntgens per hour with a source of 1500 curies. The source is housed at the periphery of a disc which moves through 180 deg. from the "protected" to the "exposure" position. Adequate clearances are possible without any loss of protection, as the source wheel is, in all positions, totally surrounded by the lead and heavy metal protective shield. The source wheel is driven by a motor against a mechanical stop, eliminating the wear and inaccuracy of latching contacts. A magnetic clutch between the motor and the source wheel ensures its immediate return by means of a lightly loaded spring if the electricity supply is interrupted. Interchangeable diaphragms of tungsten copper alloy provide a beam of radiation 6in or 12in wide by 5ft long (15cm or 30cm by 150cm) at a distance of 12ft (360cm) from the source.

During the setting up of the container, a simple but powerful light projector is used to indicate the position of the beam on the specimen at distances up to 20ft (600cm). The light, in the form of a cross, indicates the exact position of the centre of the beam of gamma radiation. When not in use the projector may be swung out of the way, or, for transportation, completely detached.

The protective container is housed in a steel cylinder which can be rolled on its heavy steel end flanges over rough ground. A steel supporting fork is provided for slinging the unit from a crane or, with the angulating gear disengaged, for hauling the equipment up a loading ramp on to a vehicle.

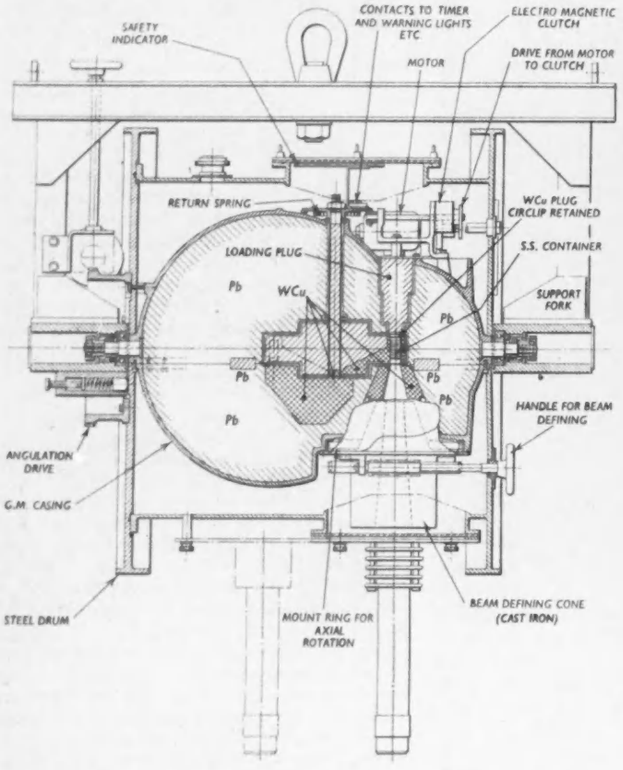
A worm wheel drive fitted to the fork is used to angulate the container and, with it, the radiation beam, through 350 deg. Thus, when supported by a crane or other suitable mounting, the container can be rotated about both horizontal and vertical axes—movements which are specially useful in the examination of spherical and cylindrical pressure vessels. The worm drive may be disengaged when the container is being moved to a new site.

The control gear is housed in a sheet steel box, for wall or desk mounting, 20in long by 12in wide by 11in deep (51cm by 30cm by 28cm), and includes exposure timer, shutter control, signal lamps, master switch with removable key, and 150ft (45m) of three-core cable.

An exposure is initiated by pressing a button; the source moves from the "protected" to the "exposure" position and starts the synchronous motor timer which has a range of one second to fifty-five minutes in steps of one second. Signal lamps indicate the position of the source at all times; red, green and amber lights are energised at a low voltage to show that all three lamps are in order. At any given time only one lamp is energised at the full voltage, to indicate the position of the source: green indicates that the source is in the "protected position"; amber that the source is moving from one position to the other, and red that the source is in the "exposure" position. Four red lamps on the container itself are also energised when the source is in the "exposure" position. All signal lamps may, in the event of power failure, be operated by "long-life" batteries included in the control system.

As shown above, operator protection is assured while moving the source to the "exposure" position. Having positioned the container and adjusted the beam to the desired part of the welded structure, the operator fixes the film or cassette on the remote side and then returns to the control, which may be 100ft (30m) or more away. Alternatively, a concrete wall from 9in (23cm) to 36in (90cm) thick may be used to provide the requisite protection. On reaching the control the operator sets the exposure timer and presses a button which brings the source from the "protected" to the "exposure" position. At the end of the preset period (and if at any time the electricity supply is interrupted) the source is automatically brought back to the "protected" position. Additional signals and interlocking relays to prevent unauthorised entry to the exposure area can be easily connected to the control. Operators can, therefore, work continuously with this container without any risk of receiving an excessive dose of radiation.

The container is dustproof and waterproof and is designed for work on large construction sites. Small currents are necessary for control functions, but the quality of the radiograph is not dependent on the maintenance of precise voltages and frequencies. No water or oil cooling is necessary, and ambient temperatures up to 150 deg. Fah. will not influence the operation of the container.



(Left) Cobalt container for industrial radiography. (Right) Cobalt container set up for radiographic examination of welded plates supplied by Whessoe, Ltd., for reactor vessel of Latina nuclear power station, Italy

SHORTER REPORTS

Birthday Honours

THE list of the Queen's Birthday Honours, which was published on Saturday, June 13, includes awards as follows to engineers and those engaged in the engineering and allied industries :

Knights Bachelor—Mr. L. C. Gamage, chairman and managing director, General Electric Company, Ltd. ; Mr. A. M. C. Jenour, chairman, Aberthaw and Bristol Channel Portland Cement Company, Ltd. ; Mr. J. R. Pearson, deputy chairman, Vauxhall Motors, Ltd. ; Mr. K. H. Preston, chairman, Stone-Platt Industries, Ltd. ; Mr. R. D. Ropner, chairman, General Council of British Shipping.

C.B.—Mr. R. Ratcliffe, deputy controller Royal Ordnance Factories, Ministry of Supply.

K.B.E.—Mr. W. E. Bassett, consulting engineer, Victoria, N.S.W.

C.B.E.—Mr. F. H. S. Brown, member, Central Electricity Generating Board ; Mr. G. R. Chappel, chief superintendent engineer, Furness, Withy and Co., Ltd. ; Mr. B. W. A. Crutchlow, deputy chief inspector of factories, Ministry of Labour ; Professor S. J. Davies, Dean of the Royal Military College of Science ; Mr. A. N. Gardiner, deputy chief engineer, Ministry of Housing and Local Government ; Dr. W. R. Hawthorne, Professor of Applied Thermodynamics, University of Cambridge ; Mr. T. Henderson, chief engineer, South of Scotland Electricity Board ; Mr. A. C. Monkhouse, lately deputy director, Warren Spring Laboratory, D.S.I.R. ; Captain J. H. Quick, chief nautical surveyor, Ministry of Transport and Civil Aviation ; Mr. E. C. Wheeldon, managing director, Westland Aircraft, Ltd. ; Mr. A. H. White, deputy chairman and managing director, Lithgows, Ltd.

Metropolitan Line Modernisation

LONDON TRANSPORT has announced the plans for the proposed new services to be run on the Metropolitan Line when the £9,000,000 programme of new trains, track widening and electrification is completed in mid-1962. The works, which have already started, comprise the electrification of 10 miles of steam-operated Metropolitan Line track between Rickmansworth, Amersham and Chesham, the duplication of a 7-mile track between Harrow-on-the-Hill and Moor Park, and replacing the old "compartment" steam and electric trains by new saloon trains to serve stations to Amersham, Chesham and Watford. The new Metropolitan Line service, together with the British Railways service from Marylebone, will give a twenty-trains-an-hour peak service beyond Harrow-on-the-Hill instead of the present fourteen or fifteen, and all trains will be of eight cars instead of the present six and eight cars.

Under the proposed plans, the service will be reorganised throughout on a fixed interval "clockface" principle, so that trains will run at easily remembered frequencies and at a fixed number of minutes past each hour. A key feature of the scheme is that the electrification, the removal of the Harrow-Moor Park bottleneck, the elimination of locomotive changes at Rickmansworth and the modern electric rolling stock will enable running times to be reduced and better punctuality to be maintained.

British Iron and Steel

THE Iron and Steel Board has reported that steel production in May averaged 384,600 tons a week, compared with 387,300 tons in April and 379,000 tons a week in May last year. The slight check in May to the rising production trend was due, of course, to the Whitsun holiday. The strip mills actually increased their output above that of the preceding month and the demand for light products was also well maintained. The demand for heavy steel, however, the Board says, was "still depressed." Pig iron production in May was at a rate of 240,500 tons a week compared with 231,300 tons a week in April. The increase was accounted for mainly by a new blast-furnace in South Wales coming into operation in May.

It is estimated that consumers' and merchants' stocks of steel fell by 180,000 finished tons in the first quarter of this year, which was considerably less than in the final quarter of 1958. Consumers' stocks are estimated to have declined by 4·4 per cent in the first quarter as against 8 per cent in the fourth quarter of last year. Stocks of all steel products, with the exception of tinplate, fell during the first quarter. Stocks held by consumers at the end of March are estimated to have been equivalent to 14·2 weeks' use at the low level of first quarter consumption ; that compares with 15·1 weeks' use at the end of 1958.

Trawsfynydd Nuclear Power Station

A LETTER of intent has been issued by the Central Electricity Generating Board to Atomic Power Constructions, Ltd.,* to enter into a contract for the design, construction, and commissioning of a 500MW nuclear power station at Trawsfynydd, North Wales. The proposals made by Atomic Power Constructions, Ltd., include a development scheme for Portmadoc Harbour to enable many of the heavy items of plant and equipment to be sent to the site by sea. The design of the power station provides for two natural-uranium graphite-moderated gas-cooled reactors operating in conjunction with steam raising units and turbo-generators to give a net station output of 500MW.

The Trawsfynydd site is about 600ft above sea level on the northern shore of the artificial Trawsfynydd lake which was created some thirty years ago to serve as a storage reservoir for the Maentwrog hydro-electric power station. This lake is large enough to provide the 35,000,000 gallons of cooling water per hour required for the nuclear station. The station will be connected by overhead line to the 275kV Supergrid transmission system at the Ffestiniog pump storage station now under construction 5 miles to the north.

The land, which is owned by the C.E.G.B., is rocky and broken and of no agricultural value. However, as the site is within the North Wales National Park very careful consideration has been given to the design of the buildings to ensure that they will blend with their surroundings and not break appreciably above the outline of the landscape. Mr. Basil Spence, O.B.E., A.R.A., president of the Royal Institute of British Architects, is the architectural consultant for the project.

The principal structures in the proposals submitted by Atomic Power Constructions, Ltd., will be two reactor buildings, a turbine house and an outdoor switching station. An outline of the proposals follows.

The graphite moderator structure is about 48ft across flats and 27ft 6in high, and contains 3720 vertical fuel element channels on a square lattice pitch of 7¼in. The moderator is built up of machined graphite blocks held together by circumferential restraint members. The channels contain fuel elements of natural uranium sheathed in a magnesium alloy can with an extended surface to give improved heat transfer and four longitudinal alloy splitters to centralise the element in the channel. The diameter of the fuel element channel is constant throughout the core. The channels outside the "flattened" zone of the reactor are gagged to ensure that heat is removed at the highest outlet gas temperature.

A fabricated steel grid carried on pillars and struts from the inner skirt of the pressure vessel supports the graphite structure. Differential expansion between the moderator and its support is accommodated by a series of ball thrust races. The graphite structure is contained in a spherical steel pressure vessel 61ft internal diameter, fabricated from plate 3½in thick. A circumferential gas seal is fitted between the pressure vessel and the graphite structure.

Heat is removed from the reactor by carbon dioxide gas at a nominal pressure of 240 lb per square inch gauge. Six boilers are connected to each reactor pressure vessel by ducts 5ft 6in diameter.

Associated with each reactor there are six boilers placed in line in two groups of three, on opposite sides of the pressure vessel. The boiler shells are 18ft internal diameter and 116ft high and are fabricated from 2½in thick steel boiler plate. A dual pressure steam cycle has been adopted, the boilers generating 65 per cent of the steam at the high pressure. Each boiler shell contains six sets of tube banks, namely, mixed economiser, l.p. evaporator, h.p. economiser, h.p. evaporator, l.p. superheater and h.p. superheater. All tubes throughout the boiler have external resistance-welded fins to improve the heat transfer between the gas and the steam.

Installed vertically below each boiler is a gas circulator, a single-stage, axial-flow fan. The circulator drive consists of a constant-speed direct-coupled 6000 h.p. induction motor running at 2950 r.p.m. During operation the gas flow is regulated by linked throttle valves in the main gas ducts and by-pass valves in re-circulation ducts.

The reactor building contains the reactor and the boilers, and measures about 300ft by 180ft at ground level and is 179ft high. Each boiler, with its gas ducts, is individually shielded along its whole length by shield walls which connect with the biological shield of the reactor itself. At boiler plinth level the building is extended to form a common circulator house containing the electric motors for the gas circulators.

On-load fuel handling is to be provided by charge machines, each of which is a composite unit capable of carrying out all operations connected with the fuel handling system on the charge face. The machines are approximately 64ft high and weigh approximately 380 tons each. Remote and local control are provided for charge machine operations but normal operation will be from a remote control room near the charge face.

Control of the station during normal operation is carried out from a central control room, sited between the two reactor buildings. There are two automatic control loops external to the reactor ; one is primarily intended to eliminate instabilities in the reactor neutron flux, the other is used for adjusting the reactor output to meet the load demand. Provision is made for full automatic control of the station if required.

The turbo-generators are arranged transversely in a turbine house which is approximately 450ft long and 220ft wide. Each generator has a maximum continuous rating of 145MW and is a four-cylinder machine designed for a dual pressure steam cycle, the steam being discharged from each turbine through six exhausts into twin condensers. The generators have water-cooled stator windings.

The steam conditions at the turbine stop valve are as follows : h.p. steam, 927 lb per square inch gauge, 715 deg. Fah. ; l.p. steam, 290 lb per square inch gauge, 685 deg. Fah. ; steam flow ratio, 65 per cent h.p., 35 per cent l.p.

The generator output will be stepped up to 275kV by 157MVA transformers connected by cables to the C.E.G.B. switching compound about 300ft away. Auxiliary transformers provide a supply at 11kV and 415V for the power station.

The circulating water pump house contains six pumps capable of circulating 500,000 gallons of water per minute, drawn from Trawsfynydd

* Atomic Power Constructions, Ltd., is a group formed at the end of 1956 and consists of Crompton Parkinson, Ltd., Fairey Aviation, Ltd., International Combustion (Holdings), Ltd., and Richardsons Westgarth and Co., Ltd., in association with Nuclear Civil Constructors (a partnership of Trollope and Colls, Ltd., and Holland and Hannen and Cubitts, Ltd., to provide the civil engineering organisation for the group).

lake and returned to it for natural cooling.

A labour camp near the site will accommodate about a thousand men. Site workshops will be provided to complete the fabrication of the reactor pressure vessel and boiler shells. A "Goliath" crane, which has a span of 250ft and a lifting height of 200ft, will be used to lift loads up to 400 tons weight.

Work on the site is due to commence on July 1, next, and the completed station should be fully operational in 1964. It will be recalled that the Central Electricity Generating Board made application to the Minister of Power for consent to build Trawsfynydd nuclear power station in August, 1957, and a public inquiry was held at Trawsfynydd in February, 1958. The Minister of Power gave his consent for the construction in July, 1958.

The main work will be allocated as follows :

Crompton Parkinson, Ltd., will be responsible for 275kV generator transformers, station, unit and auxiliary transformers, 11kV, 750MVA switchgear, 415V switchgear, switchgear control panels, auxiliary motors and alternators, cables, lighting equipment.

Fairey Aviation, Ltd., will be responsible for reactor equipment, including charge machines, control rod mechanisms, graphite machining and laying, irradiated fuel disposal equipment.

International Combustion (Holdings), Ltd., will be responsible for twelve boilers, each of 150MW heat rating, main and recirculation CO_2 gas ducting, biological shield cooling system.

Richardsons Westgarth and Co., Ltd., will be responsible for 145MW turbo-alternator sets, condensers and feed heating plant, dump condensing plant, CO_2 gas circulators and associated plant.

Nuclear Civil Constructors will be responsible for civil engineering work.

Babcock and Wilcox, Ltd., will be responsible, as sub-contractor, for two spherical reactor pressure vessels, each 61ft diameter, and one 400-ton "Goliath" crane.

Tests on Berkeley Reactor Pressure Vessel

THE first of the two reactor pressure vessels for Berkeley nuclear power station has been stress-relieved and pressure tested. Each pressure vessel is 80ft high, 50ft diameter and is fabricated from silicon-killed mild steel plate of 3in and 4in thicknesses.

The first of these operations—that of relieving the stresses set up during the welding of the pressure vessel—was carried out some weeks ago. After dismantling the internal scaffolding required for welding, a network of busbars and sheathed radiant heaters was fitted inside the vessel (as illustrated) to distribute the 2MW power supply needed to attain the temperature range of 575 deg. to 650 deg. Cent. Power was obtained from the site electricity supply. Simultaneously all external surfaces of the vessel were insulated with glass fibre lagging to reduce heat losses.

The specified stress-relieving temperature range was reached after applying heat for two days, and then the vessel was allowed to soak. After fourteen days' gradual cooling the vessel returned to atmospheric temperature. By using a variety of instruments for this operation measurements of change of shape of the vessel at various temperatures were possible. More than 300 thermocouples for temperature measurement were positioned inside the reactor, the whole stress-relieving operation being regulated from a central control room. Additionally, observation points around the reactor's perimeter were built and from them reactions inside the vessel were seen. Inside the control room were temperature controllers, multi-point temperature recorders, indicators and an intercommunication system by which direct contact was made with the observation posts.

The pressure test was carried out, on June 6–7, pneumatically. Preparation necessitated the X-raying to the highest standards set by Lloyd's, of 2500ft of weld. To make the vessel leakproof throughout the test, all inlets and outlets were blanked-off and, to ensure that the vessel was constantly situated in still air, all apertures in the 11ft thick concrete biological shielding were closed. These arrangements also kept the vessel's skin temperature at a constant 75 deg. Fah. during the test.

Pressure testing of the vessel (whose design and working pressures are, respectively, 137 lb per square inch gauge and 125 lb per square inch gauge) was at 211 lb per square inch gauge, the compressed air being supplied by four Ingersoll-Rand two-stage, 375 cubic feet per minute, compressors. From the compressors, the process air was carried, via safety valves, by pipework to a Tilghman air booster operating at 220 lb per square inch gauge and having an output of 900 cubic feet per minute.

Strain gauges to measure strains inside the reactor vessel during the test were supplied and sealed by Lloyd's and strains were registered in a specially constructed control room. At the end of the test, Lloyd's accepted the vessel for the Central Electricity Generating Board.

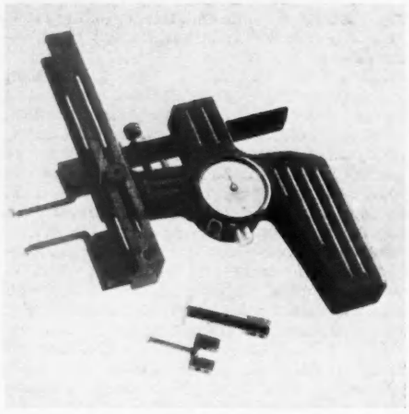
The eight boilers associated with No. 1 reactor are erected and are now being tubed. No. 1 reactor and its associated plant is expected to be completed towards the end of 1960. The pressure vessel of No. 2 reactor has now reached its full height of 80ft and its heat exchangers are being assembled in the site erection shop.

Berkeley nuclear power station is being built for the Central Electricity Generating Board by the A.E.I.-John Thompson Nuclear Energy Company. The pressure vessels and boilers are the responsibility of John Thompson, Ltd., Wolverhampton, and this company was also responsible for the stress-relieving and pressure tests described above.

Groove and Deep Bore Gauges

A NEW series of gauges manufactured by Mueller Gauge Company, of Pasadena, California, which simplify the precise measurement of grooves and deep bores, is now available from Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.

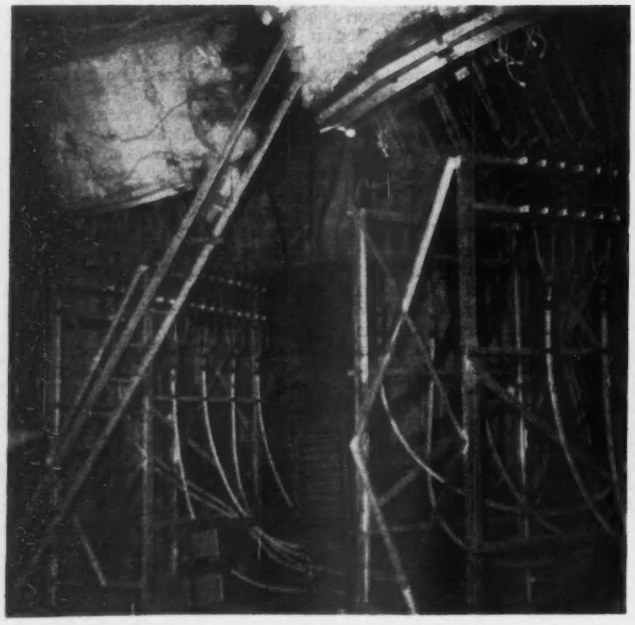
The photograph we reproduce shows one model groove gauge, which is available, with a

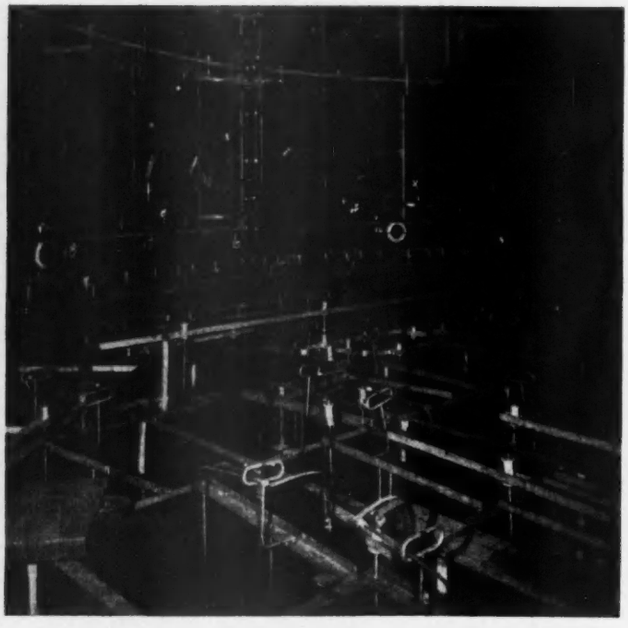


Groove gauge with interchangeable tips

range of interchangeable tips for measuring inside and outside grooves. Tip interchangeability and means provided for fast setting to gauge dimension extend the use of the instrument for universal application in measuring grooves and bores.

The gauge is set to a size range by selecting the appropriate tips and the dimensions are set with a micrometer or gauge blocks. Each gauge is fitted with a dial indicator and zero setting is fixed according to the highest point reached in setting the gauge.





(Left) Power cables and leads through CO_2 inlets to provide heating for the pressure vessel walls during the stress relieving operation (Right) The structural grid support for the reactor core is fitted with heaters for stress relieving. Similarly the walls of the vessel are fitted with stress relieving barrel heaters

Stable Low-Friction Resin

We are advised by Polypenco, Ltd., 68–70, Tewin Road, Welwyn Garden City, of an addition to their range of engineering plastics. This material, known as "Fluorosint," is a resin, comprising polytetrafluoroethylene (PTFE) and other constituents designed to improve the mechanical and thermal properties of PTFE without materially affecting its electrical and chemical characteristics.

The properties of "Fluorosint" are summarised as follows. Coefficient of thermal expansion is approximately one-sixth that of PTFE and is similar to that of aluminium copper, and a number of other metals, thus solving problems of fits and clearances of parts on thermal cycling.

Dimensional tolerances of parts in "Fluorosint" can be held to limits that are one-third to one-sixth those attainable with PTFE. "Fluorosint" parts are notably free of stresses due to thermal gradients and do not distort on thermal shock or temperature cycling.

Deformation under load is considerably less than with PTFE, especially at elevated temperatures. Hardness is increased and creep or cold flow greatly reduced.

Bearing and wear characteristics show a marked improvement over PTFE. Bearings can operate at much higher loads and speeds (PV values over 15,000).

The new material is advocated for applications in the mechanical field such as bearings, bushings and other sliding surface applications, where, hitherto, it has not been possible to utilise the extraordinary low coefficient of friction of PTFE due to the dimensional instability of this material.

As an insulating material for electrical applications, "Fluorosint" has the same dielectric strength, surface and volume resistivity, heat and moisture resistance as PTFE, although it shows a slight increase in high-frequency losses and dielectric constant.

"Fluorosint" is similar to PTFE in that it is resistant to most chemicals. Its chemical resistance combined with its good mechanical properties permits it to be used for bearings and bushings operating in corrosive conditions or under water, as well as for gaskets, packings, washers, valve seats and similar parts.

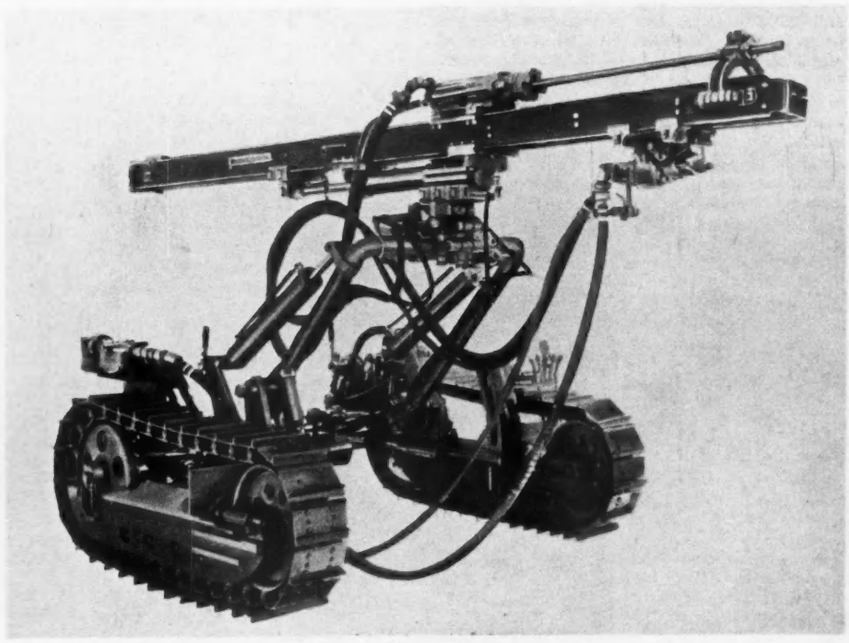
"Fluorosint" is available in the form of rod and tubular bars for fabrication into component parts or, alternatively, parts can be moulded by Polypenco, Ltd., to customers' requirements.

Self-Propelled Drilling Rig

We illustrate a self-propelled, track-mounted drilling rig on which can be mounted a 4in or 4½in drifter developed by the Consolidated Pneumatic Tool Company, 232, Dawes Road, London, S.W.6, for large diameter deep hole drilling operations in opencast mines, quarries and civil engineering works. It is equipped with two 6 b.h.p. "Power Vane" reversible pneumatic motors, which provide the motive power for propelling the rig round the site at a speed of 2½ m.p.h. A "Power Vane" compressor which supplies the compressed air is towed behind the rig.

The drilling mast of the rig can be retracted to the horizontal position for travelling or positioned at any angle for drilling by hydraulic cylinders operated by a large capacity air-operated hydraulic pump. A further pair of hydraulic cylinders can be fitted if required for inclining or swinging the drill carriage, to make mast positioning fully automatic. Heavy-duty multiple disc brakes prevent rig movement during drilling, and crawler control is through a spring-loaded lever which gives forward, reverse, turning and pivoting movements. All motor parts, brake components, clutch and drive gearings are fully enclosed to protect them from dirt and damage and a large air strainer and line oiler is fitted.

This "Tracdrill," as it is called, has an overall length of 86½in, a width of 84in, and a maximum height, with mast lowered, of 44in. Its ground clearance is 14in and the total weight, complete with drill carriage and drill, is 5265 lb.



Self-propelled, track-mounted drilling rig

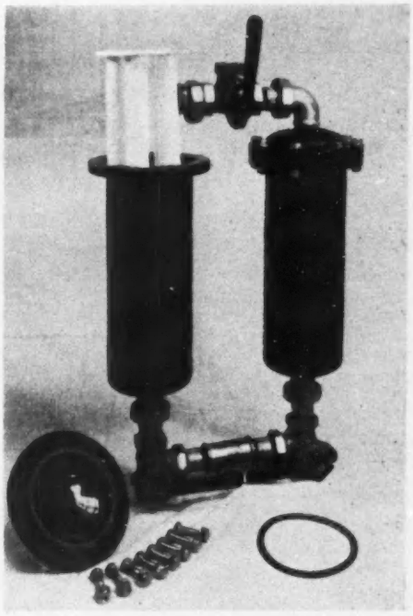
Porous Plastics

A new porous material known as "Vyon," produced from high-density polyethylene of the Ziegler type, is being made by Pritchett and Gold and E.P.S. Company, Ltd., Dagenham Dock, Essex. It is a permeable material of medium pore size; the porosity is uniform and can be predetermined and controlled in manufacture to suit specific requirements. The maximum permeability is stated to be in the region of 50 cubic feet per square foot per minute at 0·25 lb per square inch for sheet ⅛in thick. "Vyon" can easily be drilled, machined, and welded, and moulded under heat. It is light, flexible, non-absorbent and easily handled.

Uses for "Vyon" include air and liquid filtration, air-"fluidised" powder conveying, electrolytic diaphragms and aeration pads.

A interesting surgical application is in the making of orthopædic splints; "Vyon" provides a firm yet flexible support for the limb, and allows air to reach the skin.

A typical industrial filtration unit is illustrated here. The picture shows a two-compartment mains water filter with "Vyon" multi-tube filter elements. Such a unit might be used, for example, in photographic processing.



Two-compartment mains water industrial filter with "Vyon" multi-tube filter units. A typical use for this type of filter is in photographic processing

"Vyon" is made in stock sheets (smooth or matt finish, white or coloured) up to 32in by 32in and from 0·03in to 0·2in thick. For "fluidising" applications suitable thicknesses are from 0·2in to 0·1in but thinner sheets can be used if they are not heavily loaded.

Electrolytic Conductivity Recorder

A range of instruments for the recording, indication and control of electrolytic conductivity is announced by Electronic Switchgear (London), Ltd., Works Road, Letchworth, Herts. They have been developed for applications in processing and other plants in which monitoring of the condition of fluids is required. The basic instrument is an automatically self-balancing a.c. measuring bridge which employs as the measuring element the same maker's conductivity cell, of patented design, that isolates a specific volume of the electrolyte in which it is immersed. Variations of electrolytic conductivity cause the measuring bridge to become unbalanced; the resulting a.c. potential, which appears at the output of the bridge, is detected by an electronic amplifier. The output of the amplifier is applied to the signal winding of a double-wound induction servo motor. The phase of the amplified signal is determined by the sign of the conductivity change; and the phase relationship between the signal and a fixed reference a.c. potential, continuously applied to the second winding of the motor, determines the direction in which the motor must rotate to drive the measuring bridge, slidewire to restore balance.

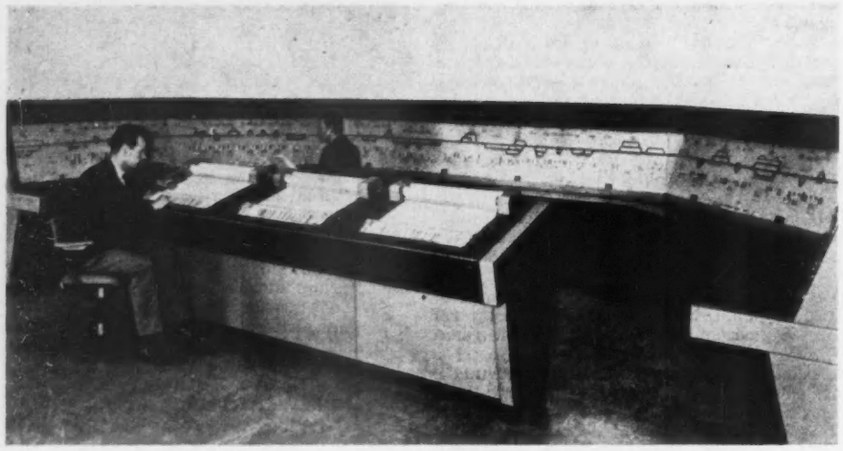
To provide automatic control, a snap action switch is actuated by a cam driven by the operating mechanism. Orientation of the cam relative to the measuring bridge slidewire contact arm may be adjusted by a panel-mounted switch with calibrated dial to effect control switching at any desired conductivity value within the range of the instrument. Measuring range is from 0·1 to 1000 micromhos in two stages, selected by a panel switch. In the instrument with recording and indicating facilities the indication is given in a window above the 10in diameter 24-hour chart. Illumination of this window indicates that the mains are on. When indication only is required, a large calibrated scale and pointer occupy the space made available by the absence of a chart, and a separate "mains on" signal lamp is fitted.

Centralised Signalling System for Swedish Line

IN order to increase the operational efficiency of its 300km-long single-track line from Oxelösund to Ludvika, the company, Trafikaktiebolaget Grängesberg – Oxelösund – Järnvägar decided some time ago to install a modern signalling system. The work was entrusted to Siemens and Halske Aktiengesellschaft, Berlin–Munich, and part of it has already been completed.

By the introduction of central control at Skogstorp station, overtaking and passing of trains in opposite directions can be carried out with a minimum of delay. Automatic point setting in the intermediate stations and in the various blocks reduces lost time so that a favourable exploitation of the system is achieved. Much of the traffic consists of heavy ore-carrying trains, but besides this there exists a lively passenger traffic in the form of trains and railcars. The line traverses mountainous country as well as flatter regions where there are a number of swing bridges over lakes. There are also seventy-nine level crossings, sixteen spur tracks to goods sidings and junctions with the Swedish State Railway.

Our first illustration shows the central control room with its 9m-long diagrammatic panel which contains remote-control push buttons for 280 points, 335 signals, sixteen sidings and three swing bridges. In addition, the control room is in charge of the platform loudspeakers for the railway staff, the heating installations of the points, and the emergency stop system. Train indicators show the trains on the line as well as those stopping at stations, and recorders note down the actual operation for comparison with the set timetable.



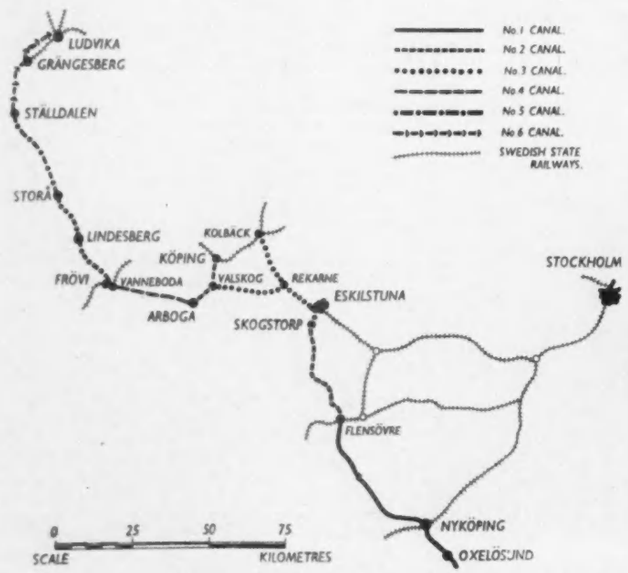
Control room at Skogstorp with diagrammatic control panel of 300km-long single track railway

For the first time, the panel has been equipped with remote controls for the 312 isolating and breaker switches. Special interlocks prevent faulty or accidental operation of these switches.

The whole of the system has been subdivided into three sections : Oxelösund–Eskiltuna, Eskiltuna–Frövi, and Frövi–Ludvika. Use is made of the Siemens inductive method to transmit signals over two channels in each case. The six channels are arranged for 1800 commands and 3500 reports, the corresponding signals being in some cases amplified by transistorised amplifiers. The whole installation is mounted in sixty racks.

A total of forty stations is equipped with diagrammatic signalling panels. Normally, the intermediate stations' boxes are not manned, but they can be switched over to manual control if required.

The automatic block installation has seventy-two block sections with 142 signals so that a great density of traffic is possible, up to four trains between two stations. Lastly, there are seventy-nine automatically controlled level crossings with 199 warning signals and sixty-eight crossing gates.



(Left) Ludvika-Oxelösund railway connecting iron ore mining districts of Ludvika and Grängesberg with the Baltic. (Right) Control panel at an intermediate station

Nuclear Power in Southern Italy

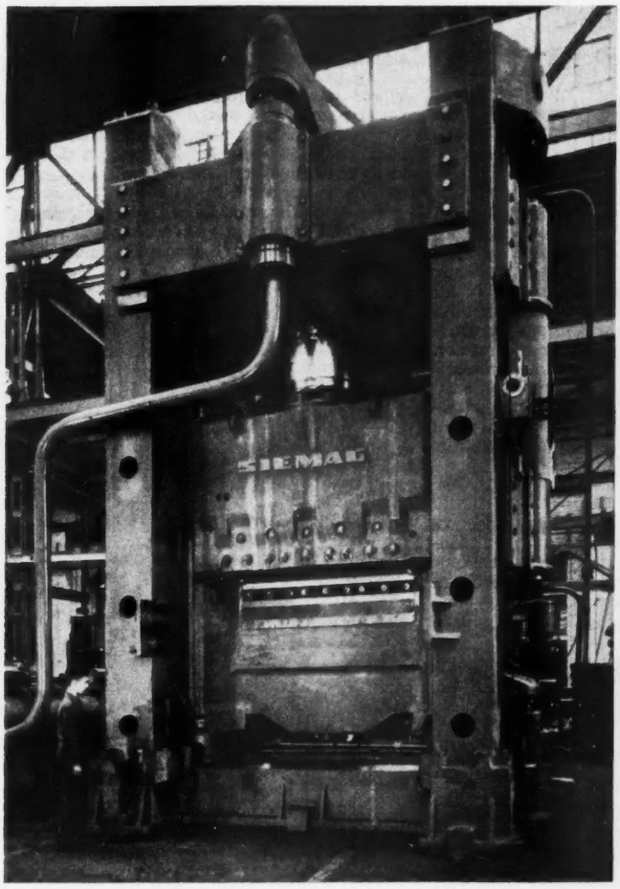
A recent report by a group of seven international experts appointed by the World Bank refers to the feasibility of generating nuclear electricity in Southern Italy. The study, known as Project E.N.S.I. (Energia Nucleare Sud Italia), began in July, 1957, and consisted of the preparation of detailed specifications for the first nuclear power plant to be built in Italy, and an examination of the nine tenders which were later submitted by suppliers from the United States, the United Kingdom and France. The study was completed in October, 1958, at which point the International Panel had analysed and reported on the nine tenders. Subsequently, the Italian utility which will be responsible for the new power plant, Società Elettronucleare Nazionale, selected the tender submitted by the International General Electric Company of New York. A summary report has been published by the World Bank.

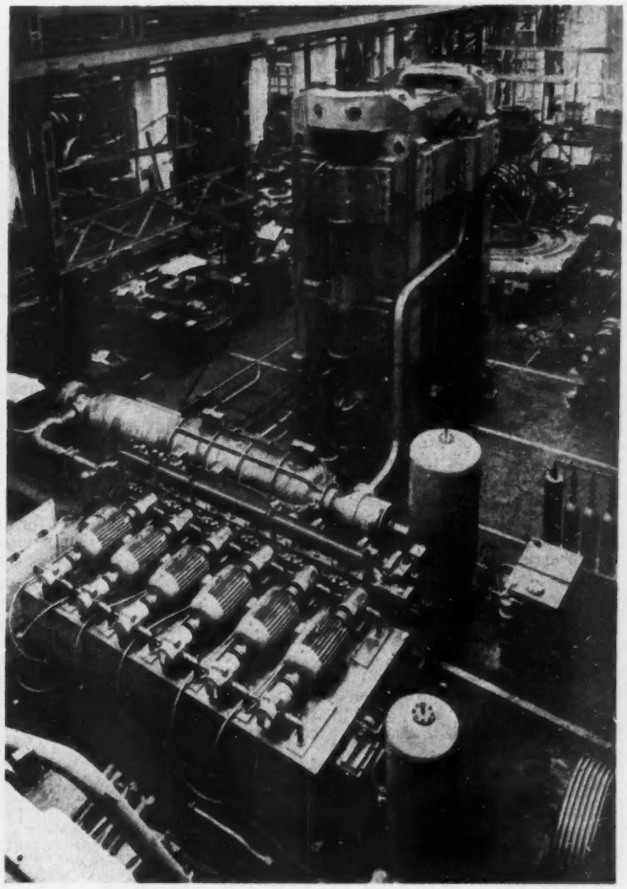
Soviet Oil Pipeline

According to reports a decision has been taken by the Eastern Bloc's Economic Mutual Assistance Council (formed in 1949) to build a 2500-mile-long pipeline from the oilfields in the Volga basin to Eastern Europe. In Byclorussia the pipeline will divide the northern branch going to Poland and the German Democratic Republic and the southern branch to Czechoslovakia and Hungary. Construction is to be started within the next four years, with technical assistance being given by the U.S.S.R., which will loan specialists and machinery. Refineries are to be built at the terminal points of the pipeline, and will supply the whole of the oil requirements in the countries mentioned, as well as furnishing the basis of local chemical industries.

Six-Metre Reflecting Telescope

Preparatory work on what is to be the world's largest reflecting telescope has begun in Leningrad, where a commission has been set up to carry out the project. The commission is headed by Academician V. Linnik, and the design team by D. Maksutov, with the participation of B. Ionnisiri. The mirror of the proposed instrument will have a diameter of 6m or just over 236in, compared with the 200in reflector at Mount Palomar, California.





(Left) 2000-ton hydraulic slab shear (back view), with top blade in the lowest position. The shear is designed to cut blooms up to 450mm by 450mm and slabs up to 1750mm by 200mm. (Right) Side view showing layout of hydraulic equipment. In the foreground, the pump sets with the horizontal pressure transmitter can be seen

Large Slab Shear

A Swedish steel works has recently installed a large slab shear, made by SIEMAG Siegener Maschinenbau G.m.b.H., Dahlbruch, Kr. Siegen/Westphalia. We show this equipment in the two accompanying illustrations. The shear has a cutting capacity of 2000 tons and is fitted with blades 2000mm long, with a maximum stroke of 500mm. Depending upon the size of slab to be cut, the number of strokes can be varied steplessly between four and twelve per minute or more.

Operation is hydraulic. Twelve pumps driven in pairs by electric motors supply pressure oil to an intensifier, which converts the oil pressure into water pressure for use in the main cylinder of the shear. In this way inflammable liquid is kept away from the neighbourhood of the hot slabs so as to remove the danger of fire in case of a leak. The subsidiary movements of the shear are, however, carried out directly by means of oil pressure. Subdivision of the hydraulic unit into several independent pump units each of which is fitted with its own safety and non-return valve, enables the shear to continue operation even if some of the pumps go out of action. An open layout makes it possible to carry out repairs expeditiously. When the shear is in use, the pumps are kept running continuously, but unload the pressure except during the actual cutting cycle, so that energy consumption is kept low.

Two different modes of operation can be employed. In either method the cutting is done in an upward direction, but in the first case the bottom blade is raised with the slab above the roller table so as to relieve the roller table of the load. In the second instance, the top blade is lowered just to the slab without touching it. The slab can, therefore, still be moved in both directions under the top blade. The latter method makes it possible to increase the number of cuttings. Top blade adjustment is done hydraulically, the amount being indicated on dials by small electric motors through electric limit switches.

The slab shear requires comparatively little headroom. Space is also saved by putting the whole of the hydraulic unit under the floor in a separate room, while above floor, by the machine, there stands only a small electric control desk.

Operation of the plant is controlled by push buttons. First, the method of operation is preselected, then the starter button is pressed. The whole cycle then proceeds automatically, the shear at the end coming to rest in the same position it was in at the beginning.

Engineering Congress in Brussels

During the period September 9–12, the Fédération Européenne d'Associations Nationales d'Ingénieurs (FEANI), 19, rue Blanche, Paris (9e), will be holding a congress in Brussels with the general theme : "The Engineer and the Industrial Development of a United Europe." The papers will review the situation in various enterprises and in different regions before and since the introduction of the Common Market. The second aspect to be dealt with concerns the energy policy of the Common Market countries and the technical and economic problems raised by the development of nuclear power. There will be a session devoted to questions arising from the provisions in the Treaties of Rome relating to mobility of labour across national frontiers, and the consequences to engineers (European technical education, conditions of entering the engineering profession, &c.).

Finally, the situation of scientific and technical personnel will form the subject of a fourth session held jointly with O.E.E.C. The annual general meeting of FEANI takes place on September 11. The congress is open to engineers of any nationality, even those not adhering to FEANI.

Large Blast-Furnace

After a construction period of one-and-a-half years what is stated to be the largest blast-furnace in the European Coal and Steel Community was blown in on May 4. It is the No. 10 blast-furnace of the August Thyssen Hütte A.G. steel works at Duisburg-Hamborn, and is the eighth furnace to be rebuilt since the war. Its hearth diameter is 9m and it has a volume of 1600 cubic metres. The charging platform is 37·4m above floor level, the bell extends to a height of 69m above the ground, while the bottom of the skip incline is 24m, and the hearth foundation 8·5m below ground level. Between 1500 and 2000 tons of iron can be produced daily, depending upon the iron content of the ore.

Operation of the furnace is largely automatic. Five smelters work on the furnace platform, but there only one man is required for the 11,000 cubic metre bunker installation. He supervises the blending of the charge and also sets up by means of push buttons programme for the skip hoist ; the actual operations are then carried out automatically.

International Computing Centre

The Preparatory Committee of the International Computing Centre held its third meeting in Rome in January. France has now ratified the Unesco convention establishing the centre and is the sixth country to do so. Argentina, Czechoslovakia, Greece, Poland, Switzerland and the United States were represented for the first time by official observers. It is hoped that the centre will be established soon and commence its work before the end of 1959. The offer of the firms Olivetti-Bull and IBM-France to install computers has been accepted on a short-term basis, retaining the possibility of installing more modern equipment later.

Neutron Physics Research at the National Bureau of Standards

BY OUR AMERICAN EDITOR

THE neutron is an electrically neutral, elementary particle which plays an essential part in many nuclear processes, including nuclear fission. Understanding the properties of the neutron and the way it interacts with matter is essential not only for this one application but for research into other fields such as controlled thermonuclear power. The effective use of high-energy accelerators and nuclear reactors in atomic and nuclear research also depends upon sufficient information about the neutron, as does the successful application of slow neutrons to the treatment of cancer. To aid in the safe and effective use of the neutron, the National Bureau of Standards established a small programme in neutron standards several years ago. As the requirements of research and industry have changed over the years, the emphasis of the programme has shifted accordingly. At present, research in this area is carried out by the Neutron Physics Section, established in 1957, under the direction of R. S. Caswell. Attention is being concentrated on the establishment and maintenance of standards of neutron source strength and thermal-neutron flux, studies of neutron penetration and slowing down, measurement of neutron and gamma-ray dose in radiation fields, and investigations of improved neutron detectors.

In recent years, the number of neutron sources in the United States and elsewhere has greatly increased, and the demand for precise measurement of neutron-radiation fields for the protection of personnel has correspondingly become much greater. However, detection and shielding are complicated by the fact that neutrons, because they lack electrical charge, have few interactions with matter, particularly with the electrons of atoms. Neutrons, however, do react with atomic nuclei, and must therefore be detected indirectly by means of other particles which result from these interactions. Such particles might be, for example, recoil nuclei from " billiard-ball," or elastic collisions, or alpha particles ejected from nuclei which have absorbed neutrons. Although detection equipment and film badges for personnel monitoring are now extensively employed in the areas of accelerators and reactors, there is still need for improvement in measurements of neutron-radiation dose. Such measurements are complicated by the presence of gamma-radiation in all neutron fields. To make possible more accurate neutron dosimetry, the Bureau has extended its programme in X- and gamma-ray dosimetry to handle the problems presented by mixed neutron and gamma-radiation fields.

Accuracy of all neutron measurements is ultimately dependent on the reliability of standards. In line with its basic functions, the Bureau therefore calibrates absolutely and maintains the national standards of neutron source strength and thermal-neutron flux. Laboratory standard neutron sources are calibrated for universities, industrial experimental stations and other government agencies for use as secondary standards in fundamental nuclear physics experiments, measurements of nuclear reactor behaviour, problems of neutron radiation protection and industrial applications of neutron beams. In addition to source calibration, neutron fluxes in nuclear reactors are calibrated by activating gold or copper foils and counting against foils activated with a standard thermal-neutron flux geometry.

A basic understanding of neutron shielding is needed in designing shields for nuclear reactors and for particle accelerators such as cyclotrons and linear resonance accelerators, where the neutron shielding problem is often an outstanding consideration. Experiments in neutron penetration are carried out by the Bureau to check neutron shielding theories. The theories can then be applied to the design of light-weight, high-efficiency shields for mobile reactors, as employed in nuclear-powered aircraft, ships and submarines. Other experiments are concerned with precise measurements of the neutron "age" in reactor moderator materials such as water and heavy water. The age is a measure of the penetration of neutrons during the slowing down process and is an important constant for determining the leakage of neutrons from a reactor. A fundamental approach to neutron problems is the direct measurement of the " neutron cross section "—the probability of a neutron undergoing a certain nuclear reaction with a given nucleus. A programme aimed at measuring these interactions is under way.

Neutron Standards

In the late 'forties, two nearly identical radium-beryllium neutron sources were constructed to serve as standards of neutron source strength. Each source consists of a capsule of 1 gramme of radium in the centre of a beryllium sphere, 4cm in diameter (Fig. 1). One source,

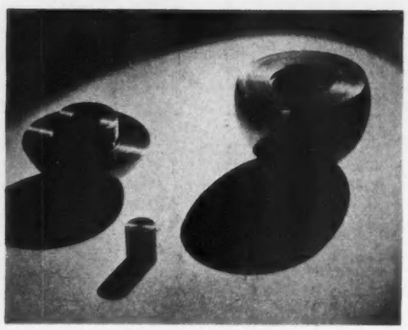


Fig. 1—Neutron source, comprising a radium capsule within a beryllium sphere

NBS-1, serves as the national neutron standard. The second source, NBS-2, is loaned to other laboratories for comparison with sources throughout the world. This second standard was recently sent to England and to Sweden for international comparisons.

In the past, most national standard neutron sources have been radium-beryllium (α, n) sources, made by mixing a radium-containing powder with beryllium powder. Although these sources have high neutron yields, they are not completely satisfactory because the neutron strength increases with time as radium decays to polonium. Any change in state of the mixed powders can lead to a change in neutron emission rate, which is, of course, undesirable in a standard source. The capsule-in-sphere radium beryllium (γ, n) source overcomes this problem as neutrons are produced only by the gamma-rays from radium acting on the beryllium in the spherical shell. While these photo-neutron sources are very well suited for standards, they are inconvenient to work with in some laboratory situations because of large gamma-ray emission. More acceptable laboratory standard sources are plutonium-beryllium (α, n) sources, which have been made available by the U.S. Atomic Energy Commission. This source, which provides low gamma-ray emission and long half-life, sometimes is used as a working standard at the Bureau.

The N.B.S. standard neutron sources have been compared, either directly or indirectly, with the national standard neutron sources of all countries known to maintain sources, including the U.S.S.R. All these sources are in agreement to within about 2 per cent of the international mean value. The national neutron source has been calibrated absolutely in two different ways. The first, and most tedious, method involved the measurement of a thermal-neutron density in a water tank surrounding the source. In the idealised situation, the water tank is large enough so that it can be assumed no neutrons escape. Each neutron from the source must therefore appear as a thermal neutron somewhere in the tank. By integrating the thermal-neutron density—measured by its effect on a foil calibrated in a known thermal-neutron density—the neutron emission rate of the source is obtained.

The second method of absolute measurement of neutron source strength involves activating a water bath (Fig. 2) containing manganese

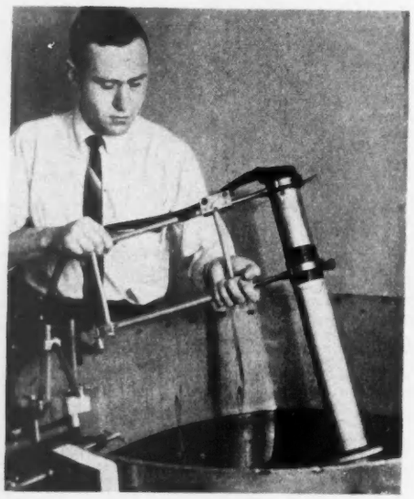


Fig. 2—Tank of manganese sulphate used as the moderator in photo-neutron source calibrations

sulphate. Neutrons from the source are slowed down in the bath and are captured finally either by manganese atoms or hydrogen atoms. The number of manganese atoms activated is measured by a method which amounts to absolute counting of the induced beta-ray activity of the manganese. The fraction of neutrons lost to hydrogen is estimated either from the measured manganese and hydrogen thermal neutron absorption probabilities (cross sections) or by changing the concentration of manganese in the bath and comparing activations.

The standard thermal-neutron flux geometry used for calibrating neutron fluxes consists of two symmetrically placed radium alpha-beryllium sources surrounded by lead and paraffin with a carbon-shielded detector slot in between. The neutrons are slowed down by the shielding materials before reaching the slot. The thermal-neutron flux in this slot has been calibrated by

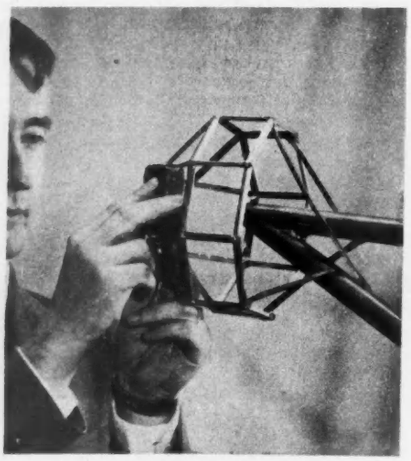


Fig. 3—Film badges mounted on metal framework surrounding an accelerator target in evaluation of neutron sensitivity

absolute counting of the boron-10 (n, α) reaction, the thermal-neutron cross section for this reaction being well known. From observations of the count rate in a proportional counter or pulse ionisation chamber containing a known amount of B^{10}, the thermal-neutron flux can be determined. The N.B.S. standard thermal-neutron flux is known to within about 2 per cent. Investigations are under way, aimed at an independent calibration of this flux by beta-gamma coincidence counting of gold-198. Unknown fluxes are calibrated against the standard by activating oils in both.

Neutron Detection and Neutron Dosimetry

The detection of neutrons in the presence of gamma-rays, or of gamma-rays in the presence of neutrons, is often a difficult problem. The most satisfactory method of analysing such mixed radiation employs a pair of detectors, one sensitive to neutrons only, and the other sensitive to gamma-rays only. Mixed-radiation dosimetry, however, is even more difficult because detectors in order to read dose must have a specific dependence upon neutron or gamma-ray energy. Instruments for neutron dosimetry may be designed to respond in two ways. The first way, which is most important for measuring the relatively hazardous fast neutrons, is to make the response of the instrument proportional to energy absorbed per gramme in soft tissue. Such an instrument may be calibrated in "rads" for tissue, where 1 rad is 100 ergs per gramme. Other neutron radiation instruments have a response which is inversely proportional to maximum permissible neutron fluxes. The reading of such an instrument gives a direct indication of radiation hazard, valid for all neutron energies up to 20 MeV.

Fast-neutron detectors consisting of zinc sulphide grains dispersed in a hydrogenous plastic "button" have been widely used because of their excellent gamma-ray discrimination. Recent work at the Bureau has demonstrated that many other kinds of phosphor material may be incorporated in buttons, yielding simple, reliable detectors with good gamma-ray discrimination. For example, plastic-phosphor matrix detectors using organic-plastic phosphors have a much faster response time than other neutron detectors which also provide good gamma-ray discrimination. By adding a material such as boron or lithium, which have large probabilities of undergoing an (n, α) reaction, to a button detector, it may be possible to develop a simple neutron survey meter with proper energy response for dosimetry from 20 MeV down. Other advantages provided by the use of inorganic phosphors, such as potassium iodide and sodium iodide, are greater button transparency and higher efficiency. The development of fast-neutron survey meters based on this plastic-phosphor matrix principle is planned by the U.S. Navy Bureau of Ships.

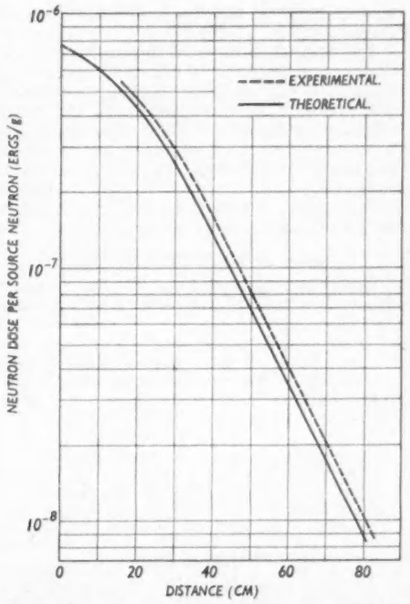


Fig. 5—Comparison of experimental and theoretical data of neutron penetration in water

Photographic film (Fig. 3) is widely used as a gamma-ray dosimeter in mixed neutron and gamma-ray fields. Although the film has a low neutron sensitivity, the extent of its neutron response must be accurately known for the correct interpretation of experiments such as radiobiological studies. A very pure neutron field must therefore be produced so that gamma radiation will not be present to mask the effects of the neutrons. To provide such a field, neutrons from the H^2 (d, n) He^3 reaction are used, which are initially free of gamma radiation. Inelastic scattering, which is responsible for gamma-ray production, is largely eliminated by the use of a specially-constructed light-weight aluminium target assembly with a Van de Graaff accelerator (Fig. 4).

To measure the small gamma-ray contamination of the radiation field, a neutron-insensitive gamma-ray dosimeter was developed. This instrument is a helium-CO_2-gas-filled counter with graphite-lined aluminium walls. Heavy-particle recoils caused by neutrons produce large pulses, which are discarded in the electronic data recording system. Small pulses, produced by secondary electrons ejected from the walls or gas, represent true gamma-ray sensitivity. Radiation fields in which the fast neutron dose is at least 100 times the measured gamma-ray dose have been measured with this arrangement.

Neutron Penetration and Diffusion

The programme of studies on neutron penetration and diffusion was instituted in 1952, when large discrepancies were noted between theoretical calculations of neutron penetration and experimental measurements (Fig. 5). A 20 per cent difference between experimental measurements of fission-neutron age in water and calculations of the same quantity caused a great deal of concern. By the use of neutrons which are nearly mono-energetic and whose energies are well known from classical mechanics, an independent critical check of slowing down theory was conducted by the Bureau for the Atomic Energy Commission. Complementary calculations of neutron penetration and diffusion are now being carried out in the Bureau's Radiation Theory Section. The experiments (Fig. 6) conducted used neutrons from the target of a 2 MeV Van de Graaff accelerator produced by the H^2 (d, n) He^3 and the H^3 (d, n) He^4 reaction. The measurements were usually carried out with water as the shield because of experimental convenience and uniformity, and the completeness of theoretical data for this substance.

In this work, three kinds of detectors have been used: Thermal neutron detectors, such as indium foils and boron counters; indium resonance neutron detectors, which are indium foils enclosed in cadmium to shield out thermal neutrons; and a polyethylene-lined ethylene-gas-filled proportional counter which acts as a fast-neutron dosimeter with a response very nearly proportional to that of tissue. The

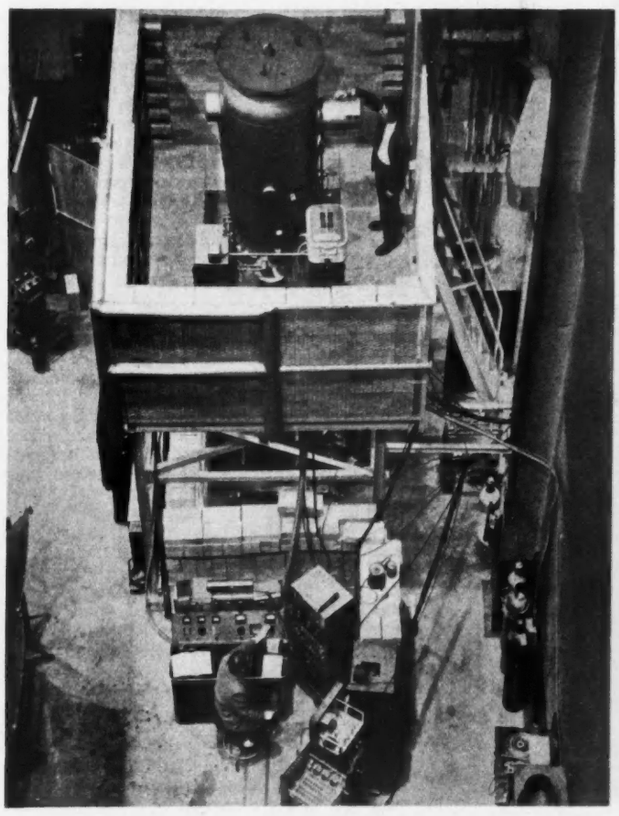


Fig. 4—Van de Graaff accelerator used at the National Bureau of Standards in the production of neutrons

Fig. 6—Experimental arrangement for determining neutron penetration in water, with target of 2 MeV accelerator at rear

measurements with thermal-neutron detectors and indium-resonance neutron detectors (Fig. 7) are of particular interest to the reactor designer who needs to know how far fission neutrons from the reactor fuel elements travel while slowing down to energies where they may be captured by uranium and produce fission in the next fuel element.

The age (one-sixth of the mean square crow-flight distance for neutron slowing down) has

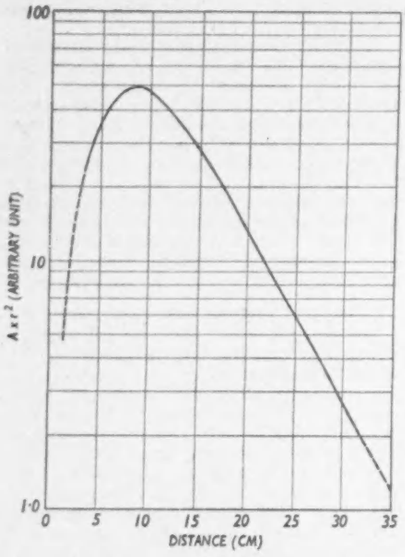


Fig. 7—Activity produced in indium foils by indium-resonance neutrons from the d+d reaction plotted against distance in water

been measured for 14·1 MeV neutrons from the H^3 (d, n) He^4 reaction, and for 2 to 3 MeV neutrons from the H^2 (d, n) He^3 reaction. The latter experiment is a more interesting check on theory, as the neutron cross sections used in the theoretical calculations are well known and the source of neutron energies lies near the average of the neutron energies for a fission-neutron source. A recent calculation is in excellent agreement with the H^2 (d, n) He^3 neutron measurement made by the Bureau. A fast-neutron dose measurement has been made with the very penetrating radiation from a 14·1 MeV neutron source. Besides providing data basic to nuclear reactor shielding theories, the results of this kind of experiment are directly applicable to shielding design for controlled thermonuclear devices.

Neutron Cross Sections

Although further experimental checks of neutron penetration calculations are necessary and desirable, the present state of agreement between experiments and calculations is generally satisfactory. Perhaps the most useful experimental information that can now be provided for penetration calculations is neutron cross section data. Although total neutron cross sections are widely known for most elements, very little information is available on differential neutron cross sections and angular distributions. Therefore, the programme will be directed more and more toward the measurement of these fundamental neutron cross sections.

Time-of-flight equipment suitable for these measurements is now being prepared. This equipment measures neutron energies by observing the flight time for a neutron to travel a given distance. Times are measured with a resolution of about 2×10^{-9} sec. Neutrons are detected in plastic scintillators followed by fourteen-stage photomultipliers. The short time interval is converted to a pulse height and recorded in a 256-channel pulse-height analyser. These experiments will be performed with the Van de Graaff accelerator in a low-scatter building which has been recently constructed for this purpose. This building has thin metal walls and a grating floor (Fig. 8) to ensure that the neutrons observed in experiments originate from the sources and the neutron scatterer, and not from the walls of the room.

The neutron, because of its lack of electrical charge, is a particularly interesting particle for investigating the nucleus. Among experimental measurements to be emphasised in the future, therefore, are determinations of angular distributions of neutrons scattered by nuclei and measurements of elastic and inelastic neutron scattering. This work is in line with the present shift of emphasis toward the provision of fundamental neutron interaction data.

Shape of the Atomic Nucleus

Recent work carried out at the Bureau shows that the energy dependence of the nuclear photon-absorption cross section can be directly related to the shape of the atomic nucleus. This approach to the determination of nuclear shapes developed out of investigations of the interactions between high-energy electromagnetic radiation and matter. One such interaction is the nuclear photo effect—the absorption of high-energy photons by the nucleus. Recent measurements of the total nuclear absorption cross section—the probability that photons will be absorbed—indicate that the cross section curve depends in part on the intrinsic nuclear quadrupole moment. Classically, this dependence means that the absorption of high-energy electromagnetic radiation by the nucleus is influenced not only by the finite size of the nucleus, but also by its shape.

The finite extent of the nuclear charge distribution was originally demonstrated by the alpha-particle scattering measurements made by Lord Rutherford. Probably the first suggestion that this charge distribution lacked spherical symmetry was made in 1944 by Brix and Kopfermann to explain irregularities they had observed in isotope shifts in some atomic spectral lines. Soon after this, departures from the interval rule for atomic hyperfine structure were explained by postulating a deformation of the nuclear charge distribution. At present, information about this deformation is also being obtained from nuclear spectroscopy; high-energy electron scattering measurements, and spectral studies of μ-mesonic atoms. However, quantitative values for the nuclear charge deformation obtained from these experiments depend also upon a detailed knowledge of either atomic or nuclear-wave functions. On the other hand, the recent cross section measurements, which were made by members of the Bureau's high-energy radiation group, can be correlated directly with the intrinsic nuclear quadrupole moment by the following rather simple classical picture.

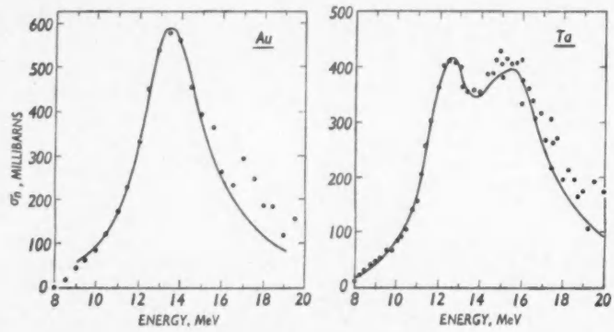


Fig. 9—Comparison of the photo-neutron production cross sections for gold and tantalum

Fig. 8—Accelerator target and detector mounted above grating floor of low-scatter building at the N.B.S.

In the classical limit, the atomic nucleus may be thought of as a figure of revolution with well-defined edges. Its mean radius is given by $R=R_0A^{1/3}$, where R_0 is a constant and A is the mass number of the nucleus. In this limit, for a uniformly charged nucleus, the static quadrupole moment is defined by $Q_0=2/5Z(a^2-b^2)$, where a and b are the half axes and Z is the nuclear charge. A classical model which has been successful in predicting many nuclear properties, particularly with respect to the nuclear photo-effect, pictures the nucleus as compressible neutron and proton fluids contained within rigid boundaries. The electric dipole absorption of electromagnetic radiation by such a nucleus takes place primarily in a single resonance line whose energy is inversely proportional to the nuclear radius of a spherical nucleus. It was pointed out by Danos and Okamoto that such a model implies that the giant resonance for the absorption of unpolarised photons by an unaligned, deformed nucleus will split into two resonances, one associated with each of the half axes of the nucleus. This prediction has now been experimentally confirmed in some detail at the Bureau.

The experiment consisted in determining the photo-neutron production cross section for two nuclei which were known to be highly deformed (terbrium–159 and tantalum–181) and for one known to have only a small deformation (gold–197). These cross sections were obtained from an analysis of the measured neutron yield curves for the three nuclei. A photo-neutron yield curve is obtained by bombarding a sample with betatron-produced X-rays and measuring the yield of neutrons as a function of the upper energy limit of the X-ray spectrum. In order to obtain a statistically significant cross section from such a yield curve, it is necessary that the statistical uncertainties be very small. To fulfil this requirement, 500,000 to 1,200,000 neutron counts were recorded at each significant point on the neutron yield curve; the yield was measured every 0·5 MeV from 7 to 20 MeV (Fig. 9). The resulting photo-neutron production cross sections all showed effects of nuclear deformations, as predicted. The giant resonances of Th and Ta were split into two resonances, while that of Au was merely broadened. The quadrupole moments evaluated from these data are in very good agreement with the best previously determined values, demonstrating the applicability of this approach.

Personal and Business

Appointments

MR. C. A. B. MALDEN has been appointed joint managing director with Mr. J. G. Cronk of Amber Oils, Ltd.

MR. JOHN LEWIS POSTLETHWAITE, has been elected president of the Royal Institution of Chartered Surveyors.

F. TAYLOR AND SONS (MANCHESTER), Ltd., has announced the appointment of Colonel L. Bullen to the position of managing director.

MR. M. C. LLOYD, assistant managing director of F. H. Lloyd and Co., Ltd., has also been appointed managing director of Lloyds (Burton), Ltd.

THE MINISTRY OF SUPPLY announces that Mr. J. H. Phillips has been appointed director of guided weapons research and development (ballistics).

THE ROYAL COLLEGE OF ART has decided to create a chair of industrial design (engineering), and has appointed to it Mr. Misha Black, from September 1, 1959.

DR. NYMAN LEVIN has been appointed director of the weapons group of the United Kingdom Atomic Energy Authority, and is succeeded as deputy director by Mr. E. F. Newley.

THE EXPORT CREDITS GUARANTEE DEPARTMENT announces that the Hon. S. G. Catto and Sir Stanley Harley have been appointed members of the Department's advisory council.

THE HAWKER SIDDELEY GROUP announces that Mr. J. F. Robertson, a director and group treasurer, and Mr. Ian C. Dick have been appointed to the board of High Duty Alloys, Ltd.

MR. R. G. BAKER has been elected president of the Institution of Mining Engineers for the year 1960-61, and will succeed Mr. T. A. Rogers at the annual general meeting to be held on January 28, 1960.

MR. GEOFFREY SMITH has been promoted export sales director of Whitlock Brothers, Ltd. Mr. Graham J. Sharpe has joined the company as home sales director, and Mr. Jack Pye has been appointed service manager.

THE COUNCIL OF INDUSTRIAL DESIGN has announced the appointment of Mr. J. Noel White to be deputy director as from January 1, 1960, when Mr. Paul Reilly, the present deputy, succeeds Sir Gordon Russell as director of the Council.

MR. B. A. CHRISTIE has been appointed managing director of I.T.D., Ltd. The following executive officers of the company have been appointed associate directors : Mr. L. A. Rochefort, general manager ; Mr. A. C. Cooper, general sales manager, and Mr. R. J. Stokes, secretary.

WELDING SUPERVISION, Ltd., has announced that Mr. Colin C. Bates, technical director, has been appointed a director of its associate Cathodic Corrosion Control, Ltd. Because of the additional duties required of Mr. Bates, Welding Supervision, Ltd., has appointed Mr. J. A. K. Stobie as chief engineer.

THE ROYAL SOCIETY announces that Sir Lawrence Bragg has been appointed Rutherford Memorial Lecturer for 1960, to deliver the lecture in New Zealand. Mr. D. J. Tritton, has been appointed Rutherford Scholar for 1959 for three years, to investigate the relationship between the manner of production of turbulence in a fluid flow and the large eddy structure of that turbulence at the department of aeronautical engineering, Indian Institute of Science, Bangalore.

THE INSTITUTION OF ELECTRICAL ENGINEERS states that the result of the ballot to fill the vacancies which will occur on the Council on September 30 next is as follows: President, Sir Willis Jackson, M.I.Mech.E.; vice-presidents, Mr. G. S. C. Lucas and Mr. O. W. Humphreys ; honorary treasurer, Mr. E. Leete ; ordinary members of council, Professor H. E. M. Barlow, M.I.Mech.E., Mr. C. O. Boyse, M.I.C.E., Mr. L. Drucquer, Mr. H. G. Nelson, M.I.C.E., M.I.Mech.E., Mr. J. R. Rylands, M.I.Mech.E., and Dr. G. A. V. Sowter ; associate member, Mr. R. A. Hore, A.M.I.Mech.E.

Business Announcements

MR. LEONARD V. TURNER, part-time member of the South Western Electricity Board, has retired.

ARENS CONTROLS, Ltd., has moved from Tunstall Road, East Croydon, to a larger factory at Trowers Way, Holmethorpe, Redhill, Surrey.

THE RUBEROID COMPANY, Ltd., states that its Birmingham office is to be moved to Central House, 75, New Street, Birmingham, 2 (telephone, Midland 3181/2).

CAUSEWAY REINFORCEMENT, Ltd., has acquired a larger factory and office block at Five Ash Works, Dover Road East, Northfleet, Kent (telephone, Gravesend 6222).

J. AND E. HALL, Ltd., and THERMOTANK, Ltd., announce that subject to approval by stockholders, they are proposing to amalgamate. The new company would be known as Hall-Thermotank, Ltd.

KEELAVITE HYDRAULICS, Ltd., Allesley, Warwicks, has concluded an agreement to manufacture and sell in Europe and the United Kingdom the rotary torque actuator (ROTAC) units of the Ex-Cell-O Corporation of America.

MR. D. J. HOPLEY, The Grange, Walton, Stone, Staffordshire (telephone, Stone 11 or 550), has been appointed technical representative of Londex, Ltd., to cover the area Cheshire, North Staffordshire, Flintshire, Caernarvonshire, Denbighshire and Anglesey.

THE HAWKER SIDDELEY GROUP announces the formation of a new company, Hawker Siddeley Brush Turbines, Ltd., within Hawker Siddeley Industries, Ltd. It is to be based in part of the existing works of Gloster Aircraft Company, at Hucclecote, Gloucester.

MR. FELIX ROGERS has retired from his position as head of the apparatus and installation equipment department of the British Electrical and Allied Manufacturers' Association, but has agreed to serve in a part-time capacity, as Continental Liaison Officer for the domestic appliances division.

Contracts

FERRANTI, Ltd., has received an order from Bruce Peebles and Co., Ltd., for a £60,000 Pegasus digital computer. Initially, the computer will be used for fundamental research and design calculations.

METROPOLITAN-VICKERS ELECTRICAL EXPORT COMPANY, Ltd., has signed a contract with Siderurgia Nacional S.A.R.L. on behalf of A.E.I. and Babcock and Wilcox, Ltd., for a complete power station for a steel works to be built at Seixal, to the south east of Lisbon. The steel works will be built near the south bank of the River Tagus and will be the first steel works in Portugal. It is planned to be put in commission by the end of 1960 and initially to produce 250,000 tons of raw steel per annum, rising to 500,000 tons in 1964. The power station plant includes two 35-tons-per-hour integral furnace boilers fired with blast-furnace gas or oil together with the boiler-house equipment supplied by Babcock and Wilcox, Ltd., delivering steam at 900 lb per square inch, 900 deg. Fah., to a 14MW, single-cylinder, steam turbine generator and associated heat exchange equipment supplying power at 6kV, three-phase, 50 cycles, to be manufactured by the A.E.I. Turbine-Generator Division.

THE HEAD WRIGHTSON MACHINE COMPANY, Ltd., has received an order from the Polish Government agency Centrozap for two hot dip tinning lines, valued at approximately £180,000 and designed to give an average output of 10,000 tons of tin plate per year. The new plant will treble Poland's present output of tin plate and this increase will be absorbed mainly by the Polish canning industry. The contract was signed in London after a delegation of technicians from Huta Lenina steel works in Poland had visited South Wales to see the company's equipment in operation. Delivery of the equipment will be completed in twelve months. The plant consists of two two-way hot dip tinning lines of the most modern design, incorporating provision for automatic feeding, final inspection, sorting and packing in the lines. In addition, there are to be supplied the engineering details for the auxiliary equipment, which includes palm oil storage and preparation tanks, acid tanks, cooling and cleaning, air blowers, fans and ducting and the fume exhausting plant.

Miscellanea

NEW COLLEGE OF ADVANCED TECHNOLOGY.—Sir Edward Boyle, Parliamentary Secretary to the Ministry of Education, announced last week that the Bristol College of Technology is to be designated as a College of Advanced Technology as from September, 1960. It will be the ninth College of Advanced Technology to be designated under the plan, announced in the Government's 1956 White Paper, for expanding technical education. Sir Edward, who was addressing a meeting at the Bristol College of Technology, said that the £85,000,000 five-year programme associated with the White Paper, together with the £54,000,000 three-year programme recently announced, was intended, amongst other things, to raise the output of advanced students from technical colleges from 9500 in 1955 to about 17,000 by the later 1960s. The plan was progressing according to schedule, and the present output of advanced students was about 11,500 a year.

ENGINEERING MATERIALS EXHIBITION.—An Engineering Materials and Design Exhibition is to be held at Earls Court, London, from February 22 to 26, 1960. It is being organised by Industrial and Trade Fairs, Ltd., Drury House, Russell Street, London, W.C.2, and will be devoted solely, as its title implies, to a display of materials and components employed in engineering design. At the time of the exhibition, it is proposed to hold a conference for engineering designers.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

METHODS OF TESTING PLASTICS PART 5 : MISCELLANEOUS METHODS

No. 2782 : 1958. Price 10s. This new publication (forty-six pages, illustrated) marks another step towards the fulfilment of B.S.I.'s intention to issue in one standard the methods of test currently used by the plastics industry. This part of the standard deals with tests which did not conveniently fall into the subdivisions chosen for the previous four parts.

In general, the presentation of contents follows the established pattern : details of test specimen, apparatus, procedure, methods of calculating the result and of reporting it. Specifically the publication deals with the following properties :—Apparent density and bulk factor, water absorption and water soluble matter, boiling water absorption, water vapour absorption, resistance to chemicals, colour bleeding, colour fastness to light, flammability, density.

ADJUSTABLE HAND REAMERS (WITH INSERTED BLADES

No. 3088 : 1959. Price 3s. For a number of years, two main types of adjustable hand reamers with inserted blades have been in production. One type, based on a well-known American pattern, is in general commercial use and has proved to be very satisfactory. When the only large users of the other type found that it was being made almost exclusively for them, they readily agreed to adopt the more popular type, thus enabling one pattern to be standardised. In addition to establishing a single type of adjustable reamer, the standard eliminates variations in sizes and ranges of expansions, and provides a series specifying one range of expansion for each size. The standard specifies general dimensions—including number, length and width of blades, overall length, thread diameters and pitches, and shank diameters and squares. Each adjustable reamer is required to be indelibly marked with the size range applicable to it and with the manufacturer's name or trade mark.

HIGH CARBON BRIGHT STEEL (SILVER STEEL)

No. 1407 : 1959. Price 4s. This revised publication introduces a simplified list of standard sizes for round bars, and it contains an additional list of sizes for square bars. Requirements for material and for quality are identical to those in the previous edition.

The material dealt with in the standard is that usually referred to as " Silver Steel," and the requirements deal with the process of manufacture, chemical composition and tolerances on sizes. The specified lengths are : 12in, 13in, 3ft, 6ft, and 1m and 2m. An appendix lists a full range of the available sizes in both rounds and squares.

BASIC DIMENSIONS FOR PRINTED WIRING

No. 3081 : 1959. Price 3s. The basic dimensions specified in this new publication apply to the printed wiring used in telecommunication and allied electronic equipment. The requirements specified apply to printed wiring forming part of a printed circuit. The six-page standard does not deal with (*a*) printed circuits : (*b*) strip lines for microwave techniques. An appendix gives recommendations on those dimensional aspects of printed wiring for which, in view of the comparatively early stage of development, it is considered unwise to specify rigid requirements at the present time. Recommendations relating to components for use with printed wiring are also given. The content of the standard will be extended as experience is gained in the production and use of printed wiring.

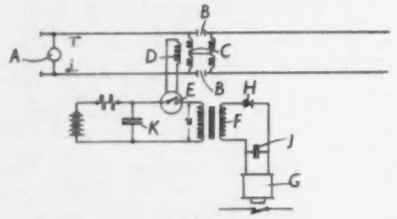
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

RAILWAY SIGNALLING

812,465. November 7, 1956.—TRACK CIRCUITS, Forges et Ateliers de Constructions Electriques de Jeumont, 5, Place de Rio-de-Janeiro, Paris, France.

Track circuits are already known in which track relays are supplied with current by generators of periodic currents, alternating or pulsating, through current-integrating means such as condensers which maintain the track relays in their attracted positions so long as the track is not "shunted" by vehicles. When the rails are traversed by alternating return traction power currents, these currents being unequal in the two rails, the unbalance may in certain cases affect the working of the means, in such a way as to prevent the dropping of the track relays. An arrangement of the integrating means in such a way that the voltage supplied to the track relays decreases when the frequency of the received currents increases is shown in the drawing. Generator *A* supplies the rails with periodic signalling currents, represented by the arrows *i*, at a frequency of a few cycles per second. The rails of adjacent block sections are separated by insulating joints *B*, but are connected inductively as usual by impedance bonds *C*. A receiving coil *D* coupled to one winding of these



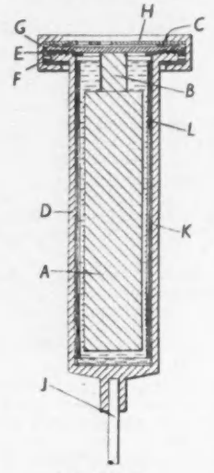
No. 812,465

impedance bonds, is connected to actuate an off-on switch *E*. This has been represented diagrammatically but it may consist of any suitable electromagnetic or electronic apparatus, such as a thyratron, on condition of being capable of operating at relatively high frequencies. An impedance is constituted by the primary winding of a transformer of which the secondary *F* feeds a track relay *G* in series with a rectifier *H*, this relay being shunted by a condenser *J*, which integrates the periodic rectified currents to apply a steady voltage to the track relay. When the traction currents are equal to one another, the receiving coil *D* is traversed only by the signalling currents *i* which have a frequency of a few cycles per second; the switch *E* alternately closes and opens the discharge circuit of the condenser *K* at this low frequency, and the voltage U attains a value U1 sufficient for the armature of the track relay to be held up. If, on the contrary, the returning traction currents are not equal, an unbalance current at 50 c/s will circulate in the windings *C* producing in the coil *D* a corresponding voltage which causes the switch to flutter at 50 c/s. This relatively high frequency compared with the normal working frequency has the effect of reducing considerably the voltage U to the value U2, and the armature of the track relay drops.—*April* 22, 1959.

ELECTRICAL ENGINEERING

811,331. February 17, 1956.—ELECTROLYTIC CONDENSER, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2.

The capacity of electrolytic condensers can be increased by enlarging the surface of the electrodes artificially. According to this invention, the surfaces of the casing designed as cathode, and which are in contact with the electrolyte, are coated with a layer of spongy precious metal. In this connection platinum black has been found particularly suitable as it consists of the most finely divided platinum and the surface of the cathode, which is in contact with the electrolyte, is very greatly enlarged compared with the surface of the casing. Owing to its nature as a precious metal it is not chemically attacked by the electrolyte used. At the same time it has the important property that acting as a catalyst it recombines the hydrogen and oxygen produced during the operation to water, so that the composition of the electrolyte suffers practically no change in the course of time. In the drawing *A* is the sintered body, to whose electrode lead *B* which at the same time acts as holding member, a tantalum plate *C* is welded, which forms the cover. This plate has concentric annular indentations which engage correspondingly arranged indentations of the flange of the condenser casing *D*. Two rings *E* and *F* act as packing. The sealing cover *G* holds the individual packing parts



No. 811,331

together. The contact can be made via disc *H*, which can be provided with a soldering lug. The connecting wire *J* for the electrolyte casing designed as the minus pole, is fixed into an extension at the bottom. The container is filled with the electrolyte, of which the contact surface with the cathode is substantially enlarged by a coating of platinum black *K*. The insulating layer *L* acts as contact protection against a short circuit between the sintered body, designed as anode, and the condenser casing. The invention may also be used with electrolytic condensers in which, instead of the casing, a non-formed electrode is designed as minus pole which in turn is coated with a spongy layer which includes either gold, silver, or one of the platinum metals in order to reduce the loss factor.—*April* 2, 1959.

POWER TRANSMISSION

812,866. October 2, 1957.—SPLINED JOINT, General Motors Corporation, Grand Boulevard, Detroit, Michigan, U.S.A. (Assignees of Earl William Glover.)

This invention relates to splined joints comprising male and female splined members. In the assembly of splined joints, it is often necessary to establish a particular angular relationship between the splined members by an indexing device. This is particularly the case where the splined joint forms part of a

No. 812,866

multi-sectioned vehicle transmission comprising propeller shafts linked by two or more universal joints whose angular relationship must be established correctly. The invention provides a simple and inexpensive indexing device for a splined joint. A separate key is mounted upon the end of one of the splined members and has a leg portion within one of its splineways and one of the splines on the other splined member is removed to accommodate the key, as shown in the drawing. The indexing device permits the members to have their splines formed without interruption. One of the splines is removed from one of the members and the key is mounted upon the end of the other splined member, preferably the male member, with a leg lying within the splineway which would have received the spline which was removed. Preferably the key is a simple cheap spring wire clip.—*May* 6, 1959.

Launches and Trial Trips

CHESHIRE, cargo liner; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for the Bibby Line, Ltd.; length between perpendiculars 450ft, breadth moulded 63ft 6in, depth moulded to shelter deck 39ft 6in, draught 27ft, deadweight 10,000 tons, service speed 15½ knots; five holds, one 50-ton, one 20-ton, two 12-ton, eight 10-ton, six 7-ton, two 5-ton derricks, sixteen electric winches; three 255kW diesel-driven generators; Fairfield-Doxford, two-stroke, opposed piston oil engine, six cylinders 700mm diameter by 2250mm combined stroke, equipped to burn heavy fuel. Launch, April 23.

TREVAYLOR, cargo ship; built by Barclay, Curle and Co., Ltd., for The Hain Steamship Company, Ltd.; length overall 470ft 6in, breadth 61ft, depth to upper deck 39ft, gross tonnage 6500; four cargo holds and deep tank, one 50-ton, one 25-ton, four 10-ton and six 5-ton derricks, steam winches; three 40kW steam-driven generators; Barclay, Curle-Doxford opposed piston oil engine, four cylinders 700mm diameter by 2320mm combined stroke, with Bibby detuner. Trial, April 27.

PURFINA ANGOLA, oil tanker; built by the Chantiers Navals de La Ciotat for the Société Purfina; length between perpendiculars 628ft 7in, breadth moulded 86ft 8in, depth 46ft 6in, draught 34ft, deadweight 33,400 tons, loaded speed 16·65 knots; two 600kW turbo-generators, one 225kW diesel-driven generator, three 1000 tons per hour pumps; two C.E.M.-Parsons geared turbines, two Foster-Wheeler boilers supply steam at 570 lb per square inch and 840 deg. Fah., 13,940 normal horsepower. Trial, April.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Thurs., June 25.—BRIGHTON, HOVE AND DISTRICT BRANCH: New Imperial Hotel, First Avenue, Hove, Sussex, "Bakelite Materials," and Film, 7.30 p.m. ★ SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, "Electrical Recording Instruments," H. W. Griffiths, 8 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed. to Sun., July 1 *to* 5.—Cavendish Laboratory, Cambridge, 1959 Convention "Television Engineering in Science, Industry and Broadcasting."

COMBUSTION ENGINEERING ASSOCIATION

Thurs., June 25.—SOUTHERN REGION: St. Ermins Hotel, Westminster, London, S.W.1, Brains Trust on "The Working of the Clean Air Act," chairman, D. G. S. M. Osborne, 10.30 a.m.

INSTITUTE OF NAVIGATION

To-day, June 19.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Shiphandling in Ice and Ice Navigation," H. C. Petersen; "The Role of Inertial Methods in Hybrid Systems of Navigation," D. E. Adams, 5 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon. to Fri., June 29 *to July* 3.—Summer Meeting in Switzerland.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, June 19.—Palace Hotel, Buxton, Joint Conference to be held in conjunction with the Institution of Engineering Inspection and the British Productivity Council, "Quality in Industry."

INSTITUTION OF PUBLIC HEALTH ENGINEERS

To-day, June 19.—Caxton Hall, Westminster, London, S.W.1, Annual General Meeting, 4.45 p.m., and "New Headworks and Reservoir, Hanningfield," W. C. Young and G. Davis, 6 p.m.

PHYSICAL SOCIETY

Thurs., July 2.—OPTICAL GROUP: Atomic Weapons Research Establishment, Aldermaston, Berks, All-day meeting devoted to the subject of "High-Speed Photography," 10.30 a.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Tues. to Sat., June 23 *to* 27.—The University, St. Andrews, Scotland, Third Annual Conference.

UNIVERSITY OF CAMBRIDGE

To-day, June 19.—Engineering Laboratory, University of Cambridge, Trumpington Street, Cambridge, Exhibition to commemorate the Centenary of the death of Isambard Kingdom Brunel, 9 a.m. to 5 p.m.

Advanced Engineering Courses

The Use of Films in Work Study. INSTITUTE FOR ENGINEERING PRODUCTION, University of Birmingham, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course, July 13 to 17. Fee 33 guineas.

Queueing Theory and Practice. INSTITUTE FOR ENGINEERING PRODUCTION, University of Birmingham, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course, June 29 to July 3. Fee 33 guineas.

Linear Programming Theory and Practice. INSTITUTE FOR ENGINEERING PRODUCTION, University of Birmingham, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course, July 20 to 24. Fee 33 guineas.

Supplement to THE ENGINEER

SWISS ACHIEVEMENTS

Issued on the occasion of the Summer visit of the Institution of Mechanical Engineers to Switzerland, June 29 to July 3, 1959.

CONTENTS

FOREWORD 2

SWISS ECONOMY AND ENGINEERING 3

Railways 5

Technical Education 7

Atomic Power 9

Water Power 10

Concrete Bridges 14

SOME MAJOR ENGINEERING FIRMS 15

Sulzer Brothers, Winterthur . . . 15

Brown Boveri & Cie, Baden . . . 17

George Fischer, Ltd., Schaffhausen . 19

Escher Wyss, Ltd., Zürich 21

Ateliers de Charmilles S.A., Geneva . 23

Société Genevoise d'Instruments de Physique 24

Assembly Plant of General Motors Suisse S.A., Bienne 24

Swiss Locomotive and Machine Works, Winterthur 25

Maag Gear Wheel Company, Ltd. . 26

Swiss Industrial Company 27

Oerlikon Engineering Works . . . 28

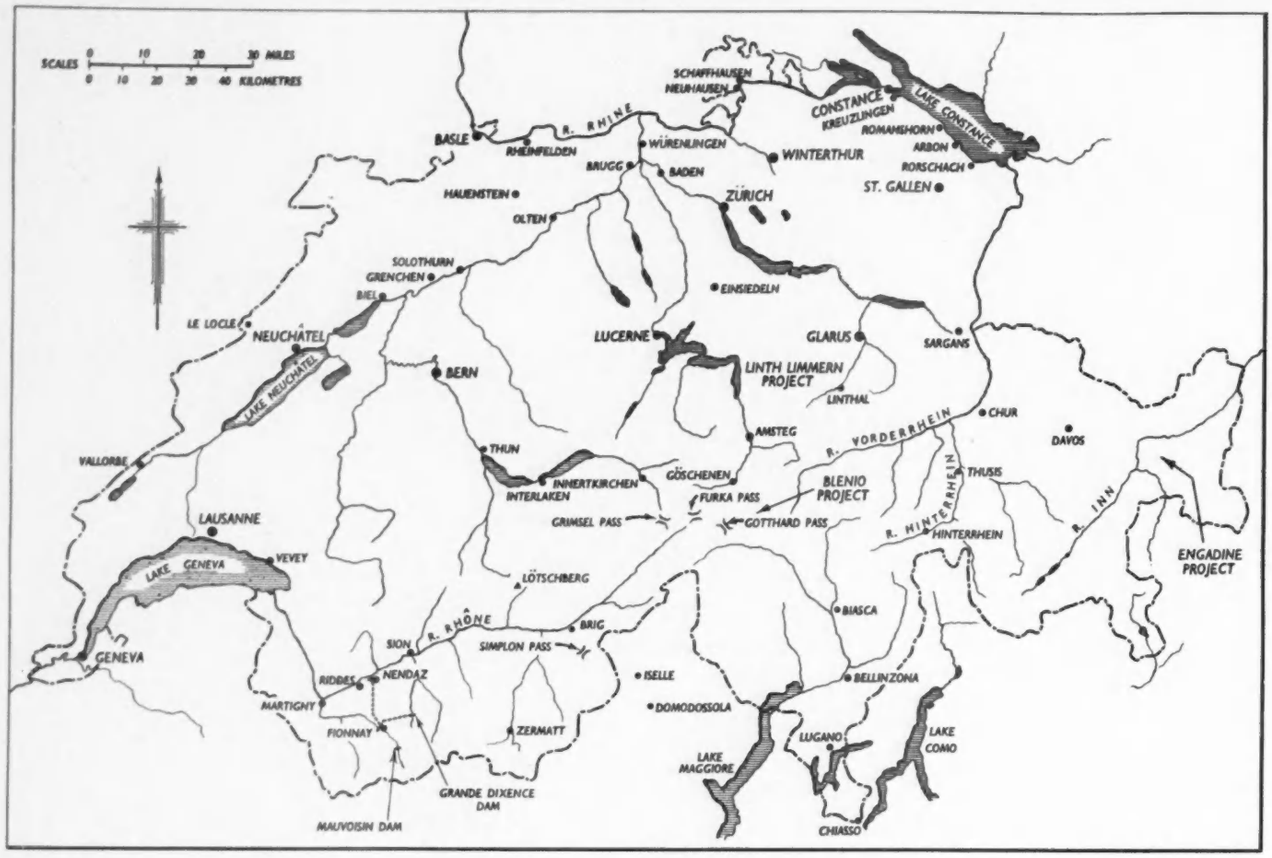
Adolph Saurer, Ltd. 30

Omega, Louis Brandt et Frère S.A. . 31

Alfred J. Amsler & Co. 32

Other Visits 32

Grande Dixence Dam



FOREWORD

On Monday, June 29, close on 250 members of the Institution of Mechanical Engineers accompanied by some 150 ladies, will be gathering in Zürich to hold this year's Summer Meeting of the Institution in that busy and also charming city. Each member will find upon arrival at his hotel a copy of this special Supplement awaiting him.

It has given us a very real pleasure to prepare this Supplement. For we have a special admiration for the Swiss, for two reasons. As engineers they are particularly noted for precision work and for the maintenance of very high standards of craftsmanship; and on the academic side the Zürich Technische Hochschule has a world-wide fame. And as people they have set the world an example in toleration and in co-operation amongst those with differing beliefs, customs and speech ; they have enriched themselves by so doing ; and they have so shared the riches that members of the Institution in their travels in the country will be hard put to it to find any slums or any sign of poverty.

It is because we have that admiration for the Swiss, and because we think the members of the Institution would like to read more about their achievements than will be revealed by the relatively few visits and excursions they can make within the compass of a single week, that we have prepared this Supplement. It does far more than describe only the works of some of the firms to be visited. We have endeavoured in addition to give the reader some impression of Swiss history. Not everyone, for example, appreciates that before deciding (some four centuries ago) to adopt neutrality as a policy, the Swiss had proved themselves in battle the best fighting men in Europe ! We have tried to give a general picture of the country's trade and of its industry. And we have added some descriptive notes about some of the more remarkable engineering achievements. In a final section we turn to mention some of the works to be visited, concentrating therein, in so far as it is possible, upon describing in detail any process or product of which the firm concerned is especially proud.

We hope and believe the members will greatly enjoy their visit to Switzerland. We hope also this Supplement will enhance their enjoyment.

Swiss Economy and Engineering

SWITZERLAND, perhaps more than any other country, is a land of contrasts. Small, with few natural resources, it is one of the wealthiest countries in the world. Widely renowned for their military achievements, whether in defence of their homeland, or while serving as foreign mercenaries, the Swiss as a nation for hundreds of years have conscientiously followed a policy of neutrality which *inter alia* kept them out of four major European wars. There are four languages current in the country and two major religious denominations, yet no racial or religious minority problems exist. The patriotic feelings of the inhabitants extend in the first instance to their own village or town, then to their canton, and only in the third place to the Federation as a whole, yet the latter has proved its stability in the face of influences which at various times disrupted most of its neighbours, often permanently. Again, although the Swiss are intensely conscious of their national individuality, they do not equate it with cultural autarky. There is no such thing as a Swiss culture, except as the manifestation on Swiss soil of the various streams of European culture.

This list could be extended. It is not, however, the task of this survey to deal in detail with the Swiss national character whose constituent traits often seem to be in irreconcilable conflict yet somehow achieve a dynamic equilibrium. We are concerned here with industrial and technological development, but since no aspect of a nation's life exists in isolation, a few words concerning the historical and general economic background may be considered relevant.

Described first by Cæsar in his "Gallic War," the area that is now Switzerland was in Roman times peopled by Celts, who in the fifth century were over-run by the Alamans and Burgundians; the first of these retained their Germanic character, the latter became assimilated to the culture of Gaul and so formed the foundation of the French element. Under the Hohenstaufen emperors, the inhabitants of the mountain valleys were charged with the defence of the important trade routes across the Alps, against the feudal lords of the surrounding countries. Early on, the will to be independent manifested itself, the first pact of alliance being concluded in 1291 between the forest cantons of Schwytz, Uri, and Unterwalden. Successful defence against Austria at Morgarten (1315) and Sempach (1386), and Burgundy (Charles the Bold), was followed by the accession of further territories, until in the sixteenth century there were thirteen sovereign cantons, as well as allied states and subject territories such as Aargau, Vaud and the Ticino. Trying to extend their power into Italy, the Swiss were defeated in 1515 at Marignano, and thereafter refrained from foreign wars. The Reformation, the subsequent decades of religious strife, and the Thirty Years' War imposed severe strains upon the Confederation which, however, managed to survive and to see its independence recognised in the Treaty of Westphalia of 1648. Later still came the French Revolution, occupation by the revolutionary armies, and the setting up of the One and Indivisible Helvetic Republic. Restored to complete independence by the Congress of Vienna, Switzerland again became prey to internal differences between the Catholic and Protestant parts of the country. The Catholic cantons set up a separate alliance in 1847 but were quickly defeated by General Dufour's army. In 1848, the federal constitution was adopted which in its revised form of 1874 is still in force at the present time. The country is a federal republic composed of twenty-two cantons. Parliament consists of two Chambers, the National Council elected directly by the people who choose one delegate for each 24,000 inhabitants, and the Council of States with two members for each canton. The executive power lies in the hands of the Federal Council of seven members who are elected for four-year periods by the two chambers in joint session. One of the seven is elected president for one year at a time. In its daily handling of affairs, the Federal Council is independent of Parliament. It controls the army (organised as a militia with a potential strength of 1,000,000 men), foreign affairs, and similar matters which concern the Federation as a whole, and has a say in cantonal projects for which federal subsidies have been granted. Other matters, in particular education (with the single exception of the Federal Polytechnic) and religious affairs, are the responsibility of the individual cantons. Where difficulties might arise from the linguistic and cultural complexity of the country, these are therefore habitually settled at the communal or cantonal level, and do not affect the stability of the Federation. An unpopular decision by Parliament is referred to the vote of the general public if more than 30,000 citizens demand it, and any citizen if supported by 50,000 others can propose constitutional modifications by the right of "initiative."

Rise of Industry

Until far into the nineteenth century, Switzerland was a mainly agricultural country. Only from 1860 onwards did the number of industrial workers exceed those engaged in agriculture. The earliest industries arose in the eighteenth century. Swiss textiles from the north and north-east of the country, and watches and clocks from Geneva and the Jura mountains, early on established their reputation abroad. Spurred by the pressure of a growing population, and seeing the new possibilities that were being realised in England and elsewhere, many enterprising Swiss began to turn their energies to the establishment of basic and engineering industries. No doubt this process received a considerable initial impetus from Napoleon's Continental Blockade, which for many years kept Europe cut off from imports of British steel and manufactured goods. Thus, we see the establishment of ironworks and foundries by Ludwig von Roll at Gerlafingen (1813) and Klus (1827), and by von Moos at Luzern in 1842. Other ironfoundries were set up by Georg Fischer at Schaffhausen (1802), the brothers Sulzer at Winterthur (1834), where the family owned a brass foundry dating from 1775, and Franz Saurer at St. Georgen, near St. Gallen (1853). Almost simultaneously commenced the manufacture of machinery by Hans Caspar Escher (1805), Johann Gottfried Reishauer (1814), J. J. Rieter, Ateliers de Constructions Mécaniques de Vevey (1842), Schweizerische Industrie-Gesellschaft of Neuhausen (1853) and others. Beginning with spinning mills, the range of mechanical production was extended within a few decades to embrace water wheels and turbines, locomotives and rolling stock, machine tools, steam and, later on, internal combustion engines; in short, the full gamut of mechanical manufacture, including items made specifically for export, such as steam turbines and marine engines.

While in this way industry developed more or less in parallel with that of other countries, there entered several factors which led to marked differences in the form of this development, as compared with the rest of Europe.

Most important in the early days was the almost complete lack of coal. As a result, instead of concentrating as in Northern France and on the Ruhr, we find that Swiss industry tended to spread out, as it had to rely on water power along the rivers, until the coming of electricity saved it from this last restriction. A second fact is the comparative lack of iron and other ores. The mountainous nature of the country for many years was a serious obstacle to effective communications, and when the railways first appeared, their development was impeded for a long time by local rivalries and the reluctance to see the powers of the central government widened by charging it with the construction and operation of a national railway system.

Area and Population

Switzerland has an area of 41,288 square kilometres, of which 23·6 per cent (including 1355·4 square kilometres of lakes), are entirely unproductive. Some 2750 square kilometres are fields and vineyards, 9800 square kilometres are forests, and about 19,000 square kilometres grass land. The population in 1957 exceeded 5,100,000, of whom nearly 40 per cent live in towns of over 10,000 inhabitants, of which the country had forty-two in 1950 (compared with eight in 1850, when the population totalled 2,400,000). The largest cantons are Zürich and Berne (876,000 and 853,000 inhabitants), followed by Vaud (400,000), Aargau and St. Gallen (about one-third of a million each.) The five largest towns are Zürich (427,000 inhabitants), Basle (201,000), Berne (161,000), Geneva (167,000), and Lausanne (118,000). All of these increased by 11·5 to 15 per cent between 1948 and 1957. The increase for all towns of over 10,000 inhabitants was 13·1 per cent, while the total population increased by 10·5 per cent.

In 1950, there were 72·1 per cent German-speaking Swiss, 20·3 per cent French, and 5·9 per cent Italian. One per cent were Rhaeto-Romansch speakers, 0·7 per cent spoke other languages. In the same year, 355,000 persons were engaged in agriculture and forestry, and 998,000 in industry and crafts of whom 169,000 were in the engineering industries, 175,000 in the building trades, 253,000 in commerce, banking and insurance, 98,000 in transport, 91,000 in the hotel trade, 65,000 in the watch and jewellery industry.

The total of those gainfully employed in Swiss industry amounted to nearly 2,200,000, of whom 70 per cent were men.

Commissioned at the end of 1958, the SBB Ferry "Romanshorn," 779 gross tons, for the Romanshorn-Friedrichshafen route is designed for 560 passengers, approximately thirty-five cars and ten to twelve goods wagons. Speed (laden) 20·4km per hour. Two "SLM" diesel engines of 600 h.p. each drive two Voith-Schneider propellers

Comparison with the years 1888 and 1930 shows that the proportion of the working population engaged in agriculture and forestry decreased from 37·5 to 21·3 and 16·5 per cent, while that in industry increased from (35·6 per cent to 38·5 per cent). Out of the total of 1917 factories, 398 factories, employing 143,800 people, are members of the Swiss Association of Machinery Manufacturers (VSM).

Machinery exports in 1957 represented a value of 2000 million francs, an increase of 11 per cent over the preceding year, and constituted 30 per cent of the total Swiss export volume. Table II shows an analysis according to categories. Last year the engineering industry exported manufactures to the value of 2160 million francs, or 32·5 per cent of all Swiss exports.*

An important sector is the watch industry which exports some 97 per cent of the total production, representing about 40 per cent of the world market. Last year's recession in exports of 14·2 per cent to a large extent hit the lower price categories (about 80 per cent of production) (Table III).

* Trade balance 1958 (1957) in millions of francs: Imports 8335·2 (8447·1), Exports 6648·8 (6713·9), Deficit 686·4 (1733·2). The trade balance is normally passive, the deficit being made up by services and "invisible exports."

TABLE I—*Number of Factories* (1957)

	Number of employees									
	Up to 10	11–20	21–50	51–100	101–200	201–500	501–1000	1001–2000	Over 2000	Total
Food industry	187	197	203	103	37	30	9	2	—	768
Textiles	220	171	245	161	108	75	8	2	1	991
Clothing	397	403	394	184	83	36	6	—	1	1,504
Equipment	47	51	77	29	12	2	—	—	—	218
Wood	714	601	419	114	28	9	—	—	—	1,885
Paper	35	46	55	34	26	19	3	1	—	219
Printing	241	250	177	85	44	15	1	1	—	814
Leather, rubber	75	57	50	12	7	7	1	—	—	209
Chemistry	115	93	96	45	20	16	6	4	1	396
Stones, earths	106	108	150	53	30	18	2	—	—	467
Metals	334	370	353	150	86	56	11	3	3	1,366
Machinery, instruments	466	487	483	206	114	93	40	24	4	1,917
Watches, jewellery	308	338	307	160	74	40	12	4	1	1,244
Musical instruments	8	13	18	6	4	1	—	—	—	50
Power, gas, water	138	79	66	10	3	1	—	—	—	297
Total	3,391	3,264	3,093	1,352	676	418	99	41	11	12,345
Number of workers	23,620	48,469	99,196	95,261	93,709	123,968	67,357	55,382	39,951	646,913

TABLE II—*Swiss Engineering Exports* (*Millions of Francs*)

Group	1957	1956
Textile machinery (excluding sewing machines)	315·2	285·2
Sewing machines	47·8	50·9
Machine tools	294·1	274·0
Internal combustion engines	120·1	90·1
Steam plant and steam turbines	40·3	42·7
Hydraulic plant, compressors and pumps	38·1	38·0
Food machinery	111·3	85·8
Electric generators	126·2	119·8
Mathematical and physical instruments	39·0	31·7
Electrical apparatus and instruments	136·0	125·9
Electricity meters, electric measurement instruments, telephone equipment, &c.	85·5	86·2
Typewriters, calculating machines	57·4	56·6
Cinematographic equipment	20·8	18·6
Vehicles	68·9	65·5
Other products	520·1	462·2
Total	2020·8	1833·2

TABLE III—*Exports of the Swiss Watch Industry*, 1950–1958

Year	Complete watches or mechanisms: Million pieces	Complete watches or mechanisms: Million francs	Other products, million francs	Total exports, million francs
1950	24·2	656·7	73·5	730·2
1951	33·5	916·9	93·4	1010·3
1952	33·3	990·3	92·2	1082·5
1953	33·0	1016·8	89·9	1106·7
1954	31·1	953·1	86·8	1039·9
1955	33·7	984·1	92·8	1076·9
1956	39·7	1134·5	100·0	1234·5
1957	40·0	1195·8	107·3	1303·1
1958	33·3	1026·8	91·3	1118·1

IRON AND STEEL

The consumption of iron and steel in Switzerland is of the order of 750,000 tons per annum (1955) of which 150,000 tons are used by the mechanical engineering industry. Some 50,000 tonnes of slabs and blooms are imported annually by the rolling mills.

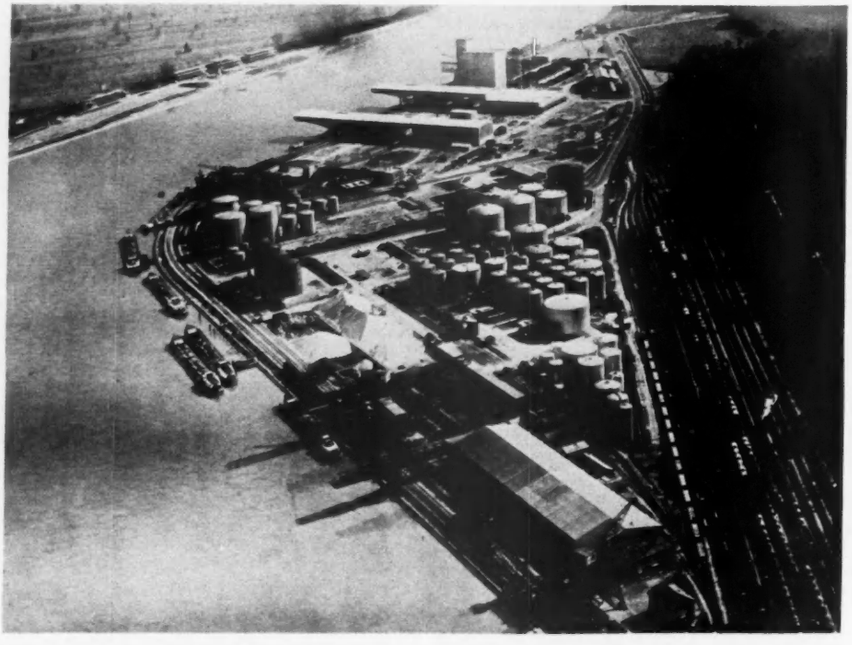
Although iron ore is found at Gonzen near Sargans (50 per cent pure haematite) and Herznach (30 per cent pure oolite), most of the 80,000 tons produced annually is exported since such small amounts cannot be economically processed into steel. The iron content would in any case only cover two-thirds of the total requirements for rough-rolled steel products.

Crude iron production amounting to 40,000 to 50,000 tons annually is carried out in the electric low-shaft furnace which since

41·4 to 43·9 and 46·3 per cent, and in commerce, banking and insurance from 4·6 to 9·8 and 11·8 per cent. It should be noted, however, that in spite of the decrease in the number of agricultural workers, the value of agricultural production between 1911 and 1956, increased from 939·6 to 2526·4 million francs per annum.

The sizes of factories and their distribution in the various branches is shown in Table I, which refers to the year 1957. We are struck at once by the preponderance of small and medium-size firms. Perhaps even more characteristic for Switzerland is the near-absence of very large concerns. It has been suggested that this is primarily due to the individualism of the Swiss, both employers and workers, who dislike being submerged in large organisations, and to their reluctance to leave their native communities, which materially helped to prevent the exaggerated growth of urban centres. Many industrial workers in the villages and small towns still have their own smallholdings. During 1958, the number of factories increased by 200, that of persons employed decreased by 20,000.

As regards the engineering industry, the numbers of workers employed increased both absolutely, from 189,000 in 1948 to 249,000 in 1957, and relatively to the total number of industrial workers under the factory act



Oil tanks and unloading installations at the Port of Au (Basel-Land), on the Rhine, upstream of the city of Basle. The major port facilities are situated at the downstream border of Basle, the "Three Countries Corner"

1943 (Choindez plant) has superseded the coke-fired blast-furnace. The electric process is, however, economically feasible only during the summer months when hydro-electric power is plentiful.

Until the second world war cut off over 90 per cent of steel imports, only special steels were produced in the country. Under pressure of the shortage, a steel industry on a scrap basis was created.

Total iron ore deposits are estimated to amount to 70,000,000 tons, with an iron content of about 20,000,000 tons. Most of the Swiss coal of which there are 10,000,000 tons which can be mined economically, is found in the district around Chandoline (Valais). It consists of anthracite with high ash content and of poor quality which is, however, suitable for use in the electric smelting process. There are two firms producing crude iron, and four steel producers. In addition, Switzerland has four steel foundries, three hot rolling mills which are attached to the steel works, seventy-three foundries for grey cast iron and two for malleable iron, twenty-eight forges, nine cold rolling mills, four bar and twelve wire mills. The whole of the industry employs some 20,000 persons.

Aluminium

The only other basic industry of importance concerns the production of aluminium. Paul Héroult who had patented his electrolytic process in 1886, having in vain tried to commercialise it in France, in the following year came to an agreement with the Swiss family Neher to set up a plant at Neuhausen where hydro-electric power was available from the Rhine. The success of his 6000A furnace led to the founding in 1887, of the Schweizerische Metallurgische Gesellschaft (Société anonyme pour l'industrie de l'aluminium) of Neuhausen. This was transformed a year later into the present Aluminium-Industrie-Aktiengesellschaft (AIAG). This company established works at Rheinfelden (Germany), Lend (Austria) and on the upper Rhône and its tributaries in the Valais, where the Chippis plant went into production in July, 1908. Another firm which dates from this period is the Société des Usines de l'aluminium de Martigny S.A., of Martigny, a subsidiary of Gebr. Giulini G.m.b.H., Ludwigshafen.

By 1954, the Chippis works operated six hydro-electric power stations totalling 200MW, and having an annual generating capacity of 1GWh. Its 1956 output capacity amounted to 28,000 tons, while Martigny can produce another 4000 tons. All raw materials are imported.

The rolling of aluminium, first undertaken at Neuhausen in 1892, began at Chippis in 1929. Other rolling mills are at Kreuzlingen, Münchenstein, Rorschach (Aluminiumwerke A.G. Rorschach, a subsidiary of Aluminium, Ltd., of Canada), Lauffen, Thun, and so on. The combined output of the metal and of rolled products covers the needs of Switzerland, leaving a surplus for export.

Shipping

It may seem strange at first sight to hear about shipping in connection with a mountainous country like Switzerland. Nevertheless, on the extensive lakes there are over 100 vessels about half of them motor vessels, the remainder steamers as well as two diesel-electric and several petrol-engined units (page 4). Passenger fares comprise nine-tenths of the takings; in 1952, nearly 8,000,000 passengers were carried on the lakes.

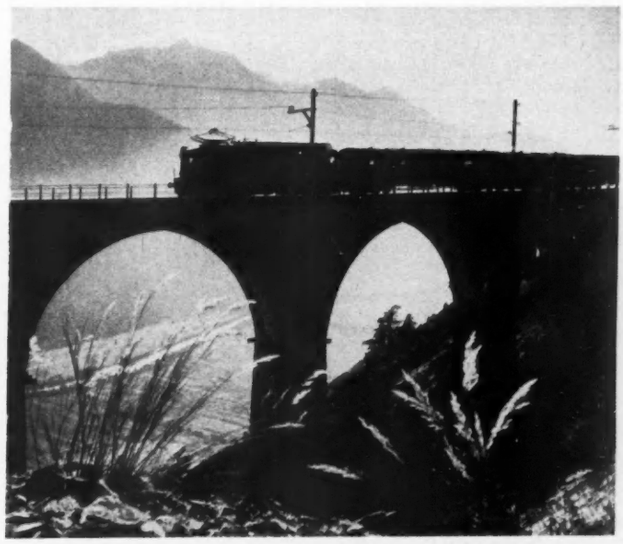
Of outstanding importance for goods traffic is the Rhine, which for many years now has been under the control of an international commission at Strasbourg. The first steamer reached Basle in 1838. After years of neglect owing to the coming of the railways, interest in Rhine shipping reawakened at the turn of the century. Since 1904, commercial shipping extends to Basle, which has a port area of 88 ha, with 4·5km of quays. Annual traffic last year amounted to 4,900,000 tons (94 per cent upstream traffic), in 1957 the figures were 5,400,000 tons (93 per cent upstream). In 1952, the Swiss Rhine fleet comprised 378 units, totalling 264,000 tons. Traffic to Basle has been greatly aided by the construction of the Rhine canal (Grand Canal d'Alsace). Projects at present under negotiation or study include making the Rhine navigable as far as Lake Constance, and building a canal to connect Lake Maggiore with the Adriatic.

The right to fly the Swiss flag on the high seas was internationally conceded in 1921, and first exercised during the last war, when eleven vessels, some Government-owned, were operated between Lisbon and Mediterranean ports to bring in wheat supplies. To-day, Swiss shipping is wholly in private hands. There were, in 1954, thirty-four vessels, totalling 197,500 tons, including three tankers. The percentage of Swiss among the crews varies from 0 to 68 per cent.

Railways

By the middle of the nineteenth century, only 23km of railway (the line from Zürich to Baden) had been constructed. Legislation in 1852, and the foundation in 1856 of the Schweizerische Kreditanstalt (Crédit Suisse) removed two main causes of stagnation: the absence of a clear legal basis for long-term planning, and the lack of capital. Although a committee of experts had recommended a national railway system, the railways were to be left in private or cantonal hands, but the Federation reserved to itself decisions regarding standardisation, and the right to redeem and take over installations after twenty-five years. Legislation in 1872 maintained the principle of private ownership, but gave ultimate powers of control to the Government, which, two years later, took over the task of supervising the construction of lines and their operation. At the same time the law of 1872 gave wider technical scope by permitting the building of narrow-gauge mountain railways.

In 1870–71, the agreement to build the Gotthard line was concluded between Switzerland, Italy and Germany. Work began in 1872 on the 15km-long Gotthard tunnel, and through bad planning and inadequate equipment (shortage of compressed air for ventilation and drilling, congestion in the single headings) soon fell behind schedule. The realisation that estimates of 187 million francs were likely to be exceeded by 102 million brought about a crisis of confidence, and near-disaster. Only the heaviest pruning enabled the excess estimate to be reduced to 40,000,000 francs and the scheme to go forward. The great tunnel was completed in 1882, at a cost of 67,000,000 francs; 177 lives were lost and 403 injured in construction accidents, and many more died as the result of silicosis and other diseases. Another 113 were killed on work in connection with the approach and feeder lines, which themselves involved many major feats of engineering. Economically, the tunnel was a great success from the start of its operation; in the first year there were over 1,000,000 travellers, or four times the number which had been anticipated. In 1956, there were about 20,000,000, including 2,500,000 transit passengers, representing approximately 22 per cent of the whole of SBB passenger traffic. The main accent, however, is on goods traffic. The estimated 400,000 tons per annum were exceeded already in the first year by 13·5 per cent. At the time of nationalisation (1908) the line was carrying nearly 1,600,000 tons per year. In 1954, the Gotthard line and its approaches from Basle, Zürich, Luino and Locarno—a total of 469km, or 16 per cent of all SBB lines—carried a daily goods traffic of 9,300,000 ton-kilometres (gross), equivalent to 37·2 per cent of the SBB total. Transit traffic in 1955 was 4,500,000 tons for the whole SBB network, of which 62·2 per cent went via the Gotthard.



One of the viaducts of the Lötschberg line (completed 1913), seen towards the Rhône valley

In the beginning, goods trains carried about 100 tons net load and achieved a maximum average speed of 12·6km per hour, which, twenty years later, had risen to 23·3km per hour. Another twenty years later, after the introduction of electric traction in 1912, the best average was about 34km per hour; to-day it is 64·7km per hour. The maximum speed which in 1900 was limited to 40km per hour, is nowadays

Locomotive "Ae 6/6" on the Gotthard. This 120-ton, C_0-C_0 locomotive, first put into service in 1952, has an hourly rating of 5820 h.p. at 74km per hour, and a maximum speed of 125km per hour. Builders: SLM-MFO-BBC. By 1960, fifty such locomotives will be used by the SBB

90km per hour. Trailing loads of 320 tons in 1895 rose to a maximum of 515 tons thirty years later, or 860 tons (1200 tons on the level) with intermediate engine (permitted from 1925 onwards). While the most powerful of the steam locomotives, the "C5/6," was capable of hauling 320-ton trains up the 1 in 38·7 inclines at 30km per hour, the electric "Ae6/6," with 6000 h.p., achieves 75km per hour with a 600-ton train.

The average number of goods trains in both directions between Göschenen and Airolo rose from ten in 1882 and twenty in 1883, to fifty-nine in 1953 and eighty-five in 1955, while the SBB average is about twenty. The largest train frequency (passenger, goods and service trains) was reached with 186 trains on March 29, 1956, when 186 trains passed through the tunnel. The peak gross daily tonnage exceeds 45,000 tons per day.

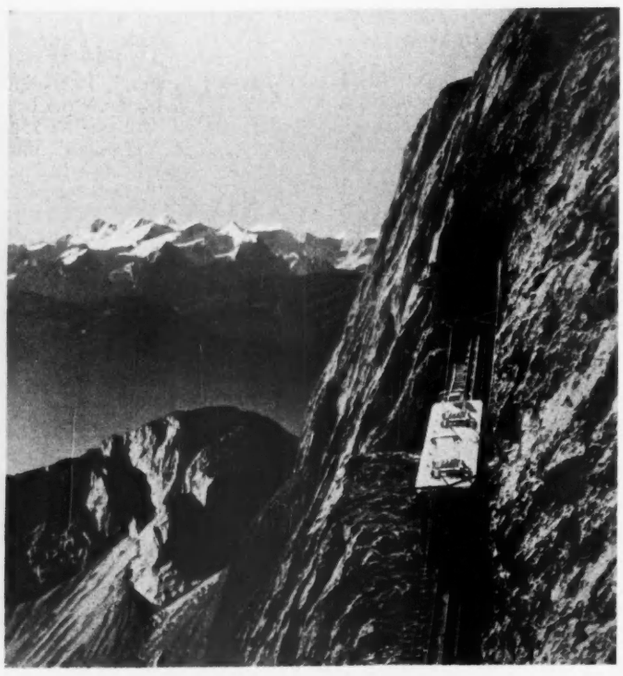
In the construction of the 19·8km-long Simplon tunnel (1898–1906), the chief engineer, Brandt, who had been one of the Gotthard builder Favre's collaborators, employed the novel idea of driving from both ends, two parallel headings instead of one, to be enlarged into single-track tunnels. This enormously improved the ventilation, as well as the flow of material, and it is doubtful if the tunnel could have been completed at all but for this innovation, in view of the particularly severe rock and temperature conditions which were encountered. Brandt also employed water-driven rockdrills of his own invention, which helped to overcome the hazards of silicosis. Like Favre, Brandt did not live to see his scheme completed, but died in the tunnel in 1899. Thirty people were killed in accidents and thirty-seven died of disease caught in the workings; 133 were seriously injured. The first tunnel was put into service in 1906, and four months later electrified at 3kV, three-phase, by Brown, Boveri & Cie, this being the first normal gauge electrification in Switzerland. The series of major Swiss tunnels which had opened with the old Hauenstein tunnel in 1857, now concluded with the Lötschberg (1909–1911, 14·6km), Grenchenberg (1915, 8·6km), and the Mont d'Or (1915, 6·8km); finally, the second Simplon tunnel was completed between 1912 and 1922, both tunnels together costing 118 million francs.

The railway crises of the 1870s which also involved the failure of the east-west Schweizerische Nationalbahn, with the resulting need for Federal assistance (for which special legislation had to be passed) had renewed the demand for nationalisation. As, however, the legally fixed redemption sum in 1883 exceeded the assets, the Federation refused to take over, but instead sought to improve business practice by passing an Audit Law (made more stringent in 1896). Eventually, in 1898, a majority of the electorate voted in favour of nationalisation, which was carried into effect over a number of years, the various companies being taken over by the Swiss Federal Railways (SBB).

The Swiss Federal Railways organisation came into existence in 1902, when the nation purchased the five largest railway companies in the country. Subsequently, other lines were acquired, and the system now embraces some 2900 route-kilometres. Of the private or cantonal systems which remained outside the SBB, the two major ones are the Bern–Lötschberg–Simplon line (BLS) and the metre-gauge Rhätische Bahn (RhB).

Electrification at 15kV, $16\frac{2}{3}$ c/s, which had been decided upon in 1912, was pushed forward vigorously after 1916 on account of the wartime coal shortage, and extends to-day to about 98 per cent of the SBB system. Power consumption in the decade 1948–1957 increased from 881GWh to 1174GWh. The SBB owns its own power system which has seven railway power stations generating (in 1957) 710GWh per annum, and two shared power stations (Rupperswil and Etzel), generating 220GWh, and also obtains 240GWh from seven privately-owned power stations. A 20 per cent increase in power consumption is anticipated in the

Stalvedro bridge on the Gotthard railway, near Airolo



Pilatus rack railway, near Lucerne

next ten years. Of the total SBB system no less than 5½ per cent is in tunnels which number 660, 150 of them being over 300m long; there are over 3000 bridges covering a total length of 23 miles.

Rack Railways and Cableways

No article on transport in Switzerland would be complete without a reference to the rack railways and aerial cableways for which the country is so well known. Each of the many rack railways has points of interest, but for this supplement we have selected for illustration a section of the notable line up the 2131m high Mount Pilatus (shown on the opposite page). The original scheme for this railway was evolved in 1883–84 by Colonel Eduard Locher-Freuler, who developed a cogwheel traction system for steep gradients, and his brother-in-law, Eduard Guyer-Freuler. Construction started in 1886, the line being opened for regular service in June, 1889. It is claimed to be the steepest rack railway in the world, with gradients of up to 48 per cent and an average gradient of 38 per cent.

The track used in this system consists of a heavy rail which has vertical teeth down each side and is set centrally between two running rails. The vehicles have two horizontal cog wheels carried on vertical, driven shafts, and these cog wheels mesh with each side of the rack rail. Discs mounted on the shafts below the cog wheels register on guide paths below the teeth, and in addition to providing a guiding influence these discs prevent any tendency a car might have to lift off the rails. The sleepers on which the rails are fastened are anchored down into the rock or concrete foundation of the track by hook bolts up to 3ft long.

Up till 1937 services on this railway were operated by eleven steam-driven railcars, but in that year electric traction was introduced with an overhead 1550V d.c. supply. In the eight electric cars now used for carrying passengers the body is suspended by springs at four points on an underframe carried on two axles. The driving pinions meshing with the rack are situated adjacent to the axle at the lower (downhill) end of the vehicle, and their vertical shafts are driven through gearing by two 105 h.p. motors. By the axle at the upper end of the vehicle there is fitted a pair of braking pinions which engage the rack and, through worm gearing, are coupled to a horizontal shaft on which a brake drum is fitted. A ratchet device fitted on the rim of each of the four wheels engages during travel downhill. When travelling down the steep gradients vehicle retarding means are provided through dynamic braking, a screw-operated hand brake on the pinion shafts at the lower end of a car, and a hand-lever-operated brake acting on the shaft of the two pinions at the upper end of the car. The hand brakes are also automatically applied in the event of a car exceeding 9·5km per hour on the downhill journey, and in the event of a current failure or when the dead-man's pedal is released. The controls for the cars are grouped in driver's cabs at each end of the vehicles.

In March 1956, there was placed in service an aerial cableway between Fräkmuntegg and Pilatus Kulm, which, with a length of 3½ miles, is said to be the longest in Europe. On this cableway up to ninety-four cabins, each holding forty persons, can be placed in service.

It is not possible here to deal in detail with the design of this and other aerial cableways.

Visitors to Zürich will be able to see, and possibly make use of, the recently opened passenger cableway over the Lake of Zürich.

Technical Education

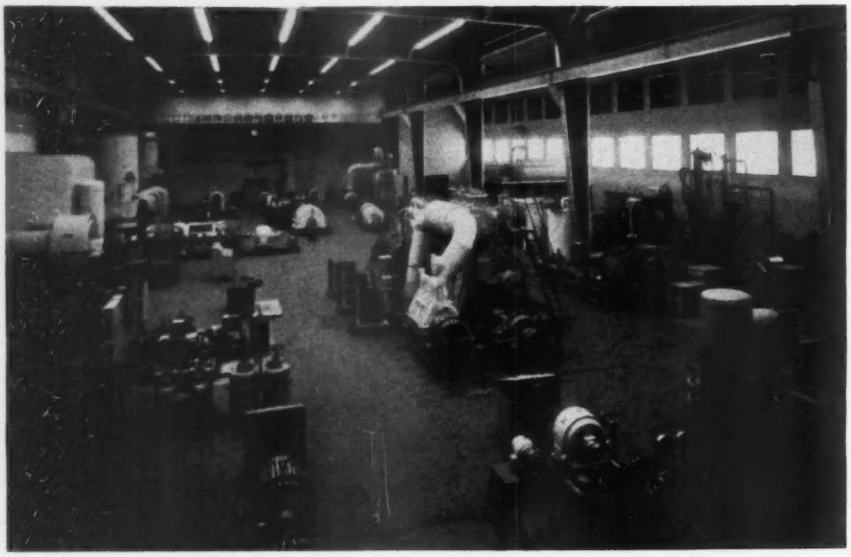
Federal Institute of Technology

One of the world's "great" schools of science and engineering, the Eidgenössische Technische Hochschule (Swiss Federal Technical University, ETH), is Switzerland's only Federal University. All the other seven universities are maintained, not by the nation as a whole, but by individual cantons who jealously guard their cultural autonomy. That the former plans for a national university embracing all branches of learning were never carried into effect, most Swiss now regard as fortunate. With a polytechnic, on the other hand, the demands for building space and laboratory equipment are heavy; in a small country an institution on the scale envisaged became more appropriately the responsibility of the nation as a whole. Control is exercised by a special board, the Schweizerischer Schulrat (Conseil de l'Ecole polytechnique fédérale), which is directly responsible to the Federal Government. At the present time there are nearly 3400 students and over 175 professors and senior lecturers. Of the 600 young people who are admitted every year, some 15 per cent are foreigners. The foreign element is welcomed as adding to the international outlook of the university and forming the basis of valuable future links with other nations. The idea of a central Swiss university goes back to the end of the eighteenth century, the years of the Helvetic Republic, when it was first formulated by P. A. Stapfer von Brugg, who aimed at a synthesis of the German form of university with that represented by the Ecole Polytechnique of Paris, founded in 1794. The plans did not materialise, but they formed the basis of the provision in the constitution of 1848 which empowered the Federation to set up a university as well as a polytechnical school. Six years later, on February 7, 1854, the law for establishing the Polytechnic in Zürich was passed. On October 15, 1855, the "Eidgenössische Polytechnische Schule" (Ecole polytechnique fédérale) was inaugurated. Instruction began the next day in the six departments which had been set up and which included building, engineering, mechanical and chemical technology, forestry and philosophical and political sciences. A notable omission is that of agriculture; distrust of science among the farmers delayed the opening of the Agricultural School until 1871. In the first year there were seventy-one immatriculated students and 160 auditors, thirty professors and six *privatdozenten*.

Interior of ETH main building (1861-1864)—architect Professor G. Semper. It houses, among other things, the central library of 450,000 volumes and 2000 journals

Among the first team of men appointed to teaching posts may be mentioned the architect Gottfried Semper, the civil engineer Carl Culmann, the thermodynamicist Gustav Zeuner, the designer Franz Reuleaux, the chemist Pompejus Alexander Bolley, and the physicist Rudolph Clausius, the discoverer of the Second Law of Thermodynamics. In the field of liberal arts there were Friedrich Theodor Vischer (German literature), Francesco de Sanctis (æsthetics and Italian literature), the botanist and entomologist Oswald Heer, the geologist Arnold Escher von der Linth, the art historian Jakob Burckhardt, and others. Two facts were of significance for the spirit of the new establishment and the manner in which it developed: the staunch adherence of the majority of the teachers to the liberal-democratic ideals of 1848–49 (many, including Semper, Bolley, Vischer, and de Sanctis, had fought on the barricades and subsequently had had to flee abroad, or had suffered imprisonment); and the preponderance of the German element. Over half of the nearly 200 applications had come from Germany, while great difficulty was experienced in obtaining teachers from France. This preponderance has continued, favoured, no doubt, by the ETH being situated in the German-speaking part of the country; although all three languages—German, French and Italian—are equally admitted, the German language is the most widely used.

The choice of Zürich as the seat of the Federal Polytechnic involved a tripartite agreement between the Federation, the Canton of Zürich and the City regarding the contributions towards the erection of buildings and their maintenance. From this



Interior of mechanical engineering laboratory. In the background are the turbine sets, circulating pumps, and (left) electric boiler of the district heating station. In the foreground stands a "SLM" four-cylinder, four-stroke diesel, in line with a turbo-supercharged, four-cylinder, two-stroke Sulzer diesel. The two crankshafts can be coupled in any phasing for vibration tests. Under construction (background, right) is a closed-circuit air turbine installation with six-stage turbine for cascade blading studies. Gland losses, which would affect measurement accuracy, are avoided by using an overhung rotor without front bearing

agreement the Canton withdrew in 1883, and the City of Zürich was bought out by the Federation in 1908. In 1908–9 the Federal Polytechnical School was reorganised with a view to giving it more the character of a university, the principal change being the replacement of the rigid compulsory curricula by standard courses of study. In 1911 the Eidgenössische Polytechnische Schule was renamed the "Eidgenössische Technische Hochschule," its French title being retained.

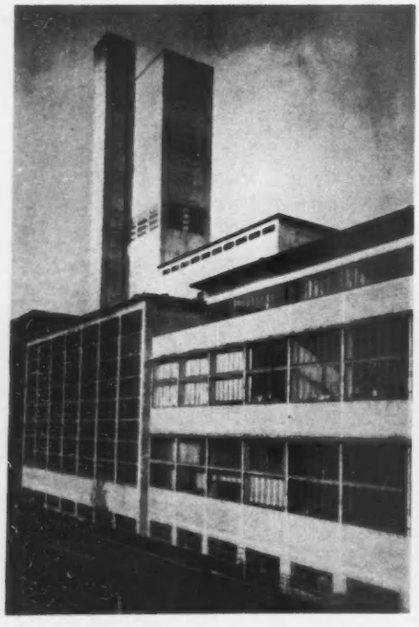
Turning to the personalities who as teachers have been associated with the ETH and who have made important contributions to their subjects, we have already cited several famous names from the early days. In the chair of civil engineering, C. Culmann (1855–1881), was succeeded by K. W. Ritter (1882–1905); others were E. Mörsch (1904–1908), K. Pestalozzi (1881–1891), C. Zschokke (1892–1898), and G. Narutowicz (1903–1919). In mechanical engineering there were Aurel Stodola (1882–1929), himself a former Polytechnic student, whose centenary was celebrated in May, and Franz Prášil (1894–1926). Electrical engineering began to come to the fore in the 1880s with H. F. Weber (1875–1912), a former student of Helmholtz; in chemistry there were J. Wislicenus (1871–1872), V. Meyer (1872–1885), G. Lunge (1876–1907), F. P. Treadwell (1893–1916), and W. D. Treadwell (1919–1954), R. Willstätter (1905–1912), H. Staudinger (1912–1926), R. Kuhn (1926–1928) and L. Rugicka (1929–1957).

An important mathematical tradition began with the appointment of R. Dedekind (1858–1862), and continued with E. B. Christoffel (1862–1869), W. Fiedler (1867–1907), H. A. Schwarz (1869–1875), F. Schottky (1882–1892), A. Hurwitz (1892–1919), H. Minkowski (1896–1902), H. Weyl (1913–1930), M. Grossmann (1907–1927), and others. Hardly less brilliant was the history of the physics department, where Clausius was succeeded by A. Kundt (1868–1870), and which subsequently included F. Kohlrausch (1870–1871), as well as Kundt's assistant and former Zeuner student at the Polytechnic, W. K. Röntgen, who later at Würzburg made the discovery of X-rays; P. Weiss (1902–1919) (magnetism), A. Piccard (stratospheric balloon ascents and bathyscaphe), P. Debye (1920–1927), and the technical physicist F. Fischer (1933–1947) (television projection), were outstanding scientists and teachers. From 1912 until 1914, A. Einstein taught theoretical physics at the institution at which he had been a student from 1897–1900. Other former students of the ETH who became famous include such names as M. Koechlin, who, together with Eiffel, designed the Eiffel Tower; O. H. Ammann, the builder of the George Washington Bridge (New York), and the Golden Gate Bridge (San Francisco); Sir Alfred Mond, Renold, and others.

A detailed description of the buildings and installations at the ETH would greatly exceed the framework of this article, and therefore cannot be given here, although it would form an excellent illustration of the energy and enthusiasm of those in charge at the ETH, and of the interest and readiness to give support shown by the rest of the community and, in particular, by industry. An impression of the generosity of the original conception, and of the scope of some of the more recent additions, will be gathered from the accompanying illustrations. The ETH has an annual budget of 17,000,000 francs, to which fees contribute a sum of approximately 3,000,000 francs. On the occasion of its centenary the ETH also received a donation of 11,000,000 francs from industry.

District Heating Station

Reference may be made at this point to one installation which may be considered to be of particular interest to engineers, i.e. the District Heating Station attached to the



The new engineering laboratories were completed in 1934 and new storeys added in 1947-48. On the left is the laboratory's district heating station (1932), which in 1943-44 was supplemented by a heat pumping plant

View from projection room into large auditorium for experimental physics, seating 650 students. The blackboards are raised or lowered by pressing on rubber tubing along the bottom edge, which pneumatically actuates the respective switches. A sliding partition allows the size of the hall to be halved. Air conditioning and panel lighting are installed

Mechanical Engineering Laboratory. The District Heating Plant, which was completed in 1932, and supplemented by a heat pump installation built in 1943–44, supplies steam at 11 atmospheres to the Cantonal Hospital, water at 180 deg. Cent. to the Cantonal Administration and the University, and water at 65 deg. Cent. to the approximately 145 other consumers, including the various ETH buildings, which are served by a grid of pipes totalling 15km and ranging from 165/156mm diameter to ¾in. The main source of heat is a group of five boilers comprising an 18 tons per hour monotube boiler for 100 atmospheres, three other boilers (two of 18 tons per hour and one of 30 tons per hour capacity) for 35 atmospheres, and one 8·5 tons per hour electroboiler for 11 atmospheres steam pressure. The high-pressure steam is either throttled, or expanded in three back-pressure turbines one of which is coupled to a l.p. condensing turbine. The total generating capacity of these sets is 4675kW. The expanded steam passes to six heat exchangers which serve the external circuits. The heat pumping plant obtains heat from the River Limmat and consists of two sets of 2×10^6 kcal per hour each, operating with Freon 11, and an ammonia set giving $1{\cdot}86\times10^6$ kcal per hour. It supplies three external circuits through exchangers, and is linked up with the main station.

Materials Testing Station

The Eidgenössische Materialprüfungs-und Versuchsanstalt (EMPA—Federal Materials Testing and Experimental Station) was opened in 1880 as a department of the ETH. The first director was Ludwig von Tetmajer. At first mainly engaged on civil engineering testing, less on mechanical engineering research, EMPA widened its field of activity when M. Ros became director (1924–1949). In 1928, the Eidg. Anstalt für die Prüfung der Brennstoffe (Federal Fuel Testing Station), and in 1938 the Schweizerische Versuchsanstalt in St. Gallen were amalgamated with EMPA.

At the instigation of Professor Ros, the Schweizerischer Verband für die Materialprüfungen der Technik (SVMT) was founded in 1926. To-day the EMPA comprises three main divisions which reflect its origin out of three separate institutes. Divisions A and B, both in Zürich, are concerned, the one with mechanical-technological testing, the other with physical and chemical investigation, while Division C in St. Gallen is occupied with testing and research of textiles, leather and paper, and allied and connected materials. A site of over 100,000 square metres has been acquired at Dübendorf, some 6km from the present Institute in Zürich, where larger quarters are being constructed for Divisions A and B which will be transferred there at the end of next year.

In 1924, the ETH was reorganised into twelve departments: Architecture, Civil Engineering, Mechanical Engineering, Electrical Engineering, Chemistry, Pharmacy, Forestry, Rural Engineering and Surveying (amalgamated in 1933), Mathematics and Physics, Natural Sciences, Military Science, and a Department for Optional Subjects. The last mentioned department has been divided since 1947 into a philosophical and political science section, and a mathematical-natural science-technological section. In the first section are offered a wide range of cultural subjects, with the idea of providing a counterbalance to technical specialisation. Students are obliged to attend during each semester at least one of these lecture courses which must be unrelated to their main subjects.

Post-War Developments

During the last war, up to 500,000 Swiss had been kept under arms, including many young men who would otherwise have entered a university. The first post-war years therefore showed a "bulge" in the number of students, immatriculations which, e.g. had been 525 in 1940–41, rising to 1213 in 1945–46. Such a rate of admission temporarily brought the student population to the 4000 mark, although by 1950 the rate had dropped. At the same time the widening scope of applied science and engineering made it necessary to provide better teaching facilities and equipment. The question arose, how much would the ETH have to expand, and how could this expansion be realised. It had previously been estimated that immatriculations would rise to over 1100 by 1965–66. This estimate appears to be on the low side, since the figure expected for 1961–62 was already reached last autumn. It would seem reasonable, therefore, to expect a student population of over 4600 by 1965–66. Possibilities for expansion in the centre of Zürich are almost exhausted. The policy, therefore, is to transfer those lines of teaching which are more or less independent of the rest to a single "Aussenstation" or Annexe, for which a site of 46 ha has been found on the Hönggerberg, about 4½km in a direct line from the centre to the north-west.

Lausanne Polytechnic

By Napoleon's Act of Meditation of 1803, Vaud became the nineteenth member state of the Swiss Confederation. As elsewhere, the French Revolution had given a strong impulse to the advance of popular education. In this connection, an important part was played in the new Canton from the beginning by the Academy of Lausanne, as the University (founded in 1537) was then called. The Law of 1806 subjected all education to the control of the Academy; the latter added courses in science and a very complete curriculum in medicine to the traditional faculties of Protestant theology, law, and letters. Higher technological training, however, was non-existent in Switzerland at the time, and students had to attend foreign institutions. Thus in 1849, over fifty Swiss students were studying abroad, twenty-five in Karlsruhe, eleven in Paris, eight in Munich, and eight in Vienna.

The Constitution of 1848 empowered the Federation to set up a National University as well as a National Polytechnic School, and in 1852, a Federal Commission reported in favour of the University being set up in Zürich and the Polytechnic in the French part of the country. However, French opposition to a National University in the German-speaking north, continued most vigorously; rather than agree to the University, they would forgo the chance of seeing the Polytechnic established on their soil. The University scheme was shelved, and the plan for a Polytechnic to be set up in Zürich was adopted. Two years previously an important step was taken in the Canton of Vaud, by the foundation of the "Ecole speciale de Lausanne, pour l'industrie, les travaux publics, et les constructions civiles." Like the Ecole Centrale in Paris, it was founded by the private initiative of five men. In the first fifty years, 975 engineering students passed through the college, of whom 421 took their diploma. The number of engineering students who followed courses between 1902 and 1953 is estimated at 3700. In the first ten years since its foundation in 1943 the School of Architecture has trained about 700 students.

In order to give expression to the intention of making it the principal technical College of the French-speaking part of Switzerland, a society with a capital of 100,000 francs was founded in 1864 for supporting the "Ecole Speciale de la Suisse Française" as it was now renamed. With an annual fee of 500 francs, it was estimated that the School would be self-supporting and even make a profit if the number of students exceeded thirty. So far, it had had 135 in eleven years. Cantonal and municipal subsidies were paid from 1865 onwards, and in 1869 the School became attached to the Academie de Lausanne, enabling fees to be reduced to 150 francs. When in 1890 the Academy took the title of University, the engineering faculty became one of the sections of the faculty of Natural Sciences. It soon outgrew its parent in importance and eventually, in 1942, it was constituted an independent faculty of the University. In the same year its scope was increased by the inclusion of a School of Architecture. Later still, in 1946, the joint title "Ecole Polytechnique de l'Université de Lausanne" was adopted by the Engineering and Architectural Schools.

Atomic Power

Although the setting-up of nuclear power stations is not an immediate economic necessity, Switzerland wishes to participate in the nuclear field which already is demonstrating its great importance not only to energy production but also in many other directions. Several approaches are being made. A training and research establishment is being set up at Würenlingen by Reactor A.G., while several power companies as well as the SBB are participating in the Suisatom A.G. which proposes to build an experimental power station. Other experimental installations are planned by ETH and Energie Nucléaire S.A. The federal government has appointed a delegate to deal with nuclear matters, who presides over an advisory commission of seventeen members. A Swiss Atomic Energy Association has been formed. Legislation is being prepared to cover the operation of reactors and questions of accident insurance.

Reaktor A.G. is the joint enterprise of the Swiss Government and over 170 Swiss firms. The American swimming-pool reactor exhibited at Geneva in 1955, was purchased and put into operation in May, 1957. Known as "Saphir," it has an average neutron flux of 6×10^{12}n per square centimetre per second. The 8m deep pool can be divided into two sections by a gate. One tangential and four radial beam holes allow radiation to be used in the experimental room. A laboratory for health physics and tracer chemistry is attached. The heavy water research reactor "Diorit" is to be completed by the end of the year. It is to have a thermal output of 12·5MW (later 25MW) and a maximum thermal neutron flux of $2{\cdot}2\times10^{13}$n per square centimetre per second. About 5·9 tonnes of natural uranium will be required, together with 9·6 tonnes of D_2O as moderator.

The project of "Energie Nucléaire S.A.," Lausanne, is a boiling water enriched uranium reactor of 20MW thermal, 5MW electrical output, to be installed by 1964 near Lausanne. It is to serve as research facility for the sponsoring firms, as well as for research and training of students at the Lausanne Polytechnic.

Hydro-Electric Power

ELECTRICAL power in Switzerland is generated preponderantly from water—over 98 per cent is hydro-electric. This has been so for many years, but more recently, Switzerland, like other countries of Western Europe has experienced fairly rapid increases in the demand for electrical power, and so hydro-electric construction has become more ambitious in scale, and more onerous to finance. Table I gives statistical data which illustrate the contemporary position ; it should be borne in mind that these figures relate to a population of about 5,000,000, and that electrical energy accounts for a shade over 20 per cent of energy consumption, from all sources, in Switzerland.

Since the national grid is virtually entirely dependent on hydro-electric power, the hydrological character of Swiss catchments is a dominant influence on the system, and on the design of new projects. The principal factor is well known, viz. the melting of Alpine snows in the spring and summer, giving heavy summer run-off which must then be stored in reservoirs for meeting the peak loads of the following winter. With a well-developed power system of this kind, the need for large seasonal storage reservoirs is of critical importance and is a deciding factor in the design of new schemes. The introduction of pumped-storage has slightly eased this problem for Swiss engineers, but nevertheless the construction of large reservoirs at high levels in the Alps remains a major aim, and accounts for some of the most expensive constructional works, as will be evident from the ensuing descriptions. Apart from this emphasis on winter power it will be seen that construction is proceeding at a rate very roughly equivalent to the installation of 600MW of plant per year up to 1962, which is more than double the annual increase for the period 1950–57. In 1956, 256MW of new plant was installed. The capital expenditure on new construction in that year was 510 million Swiss francs, out of a total of 700 million spent on the electricity system in its entirety.

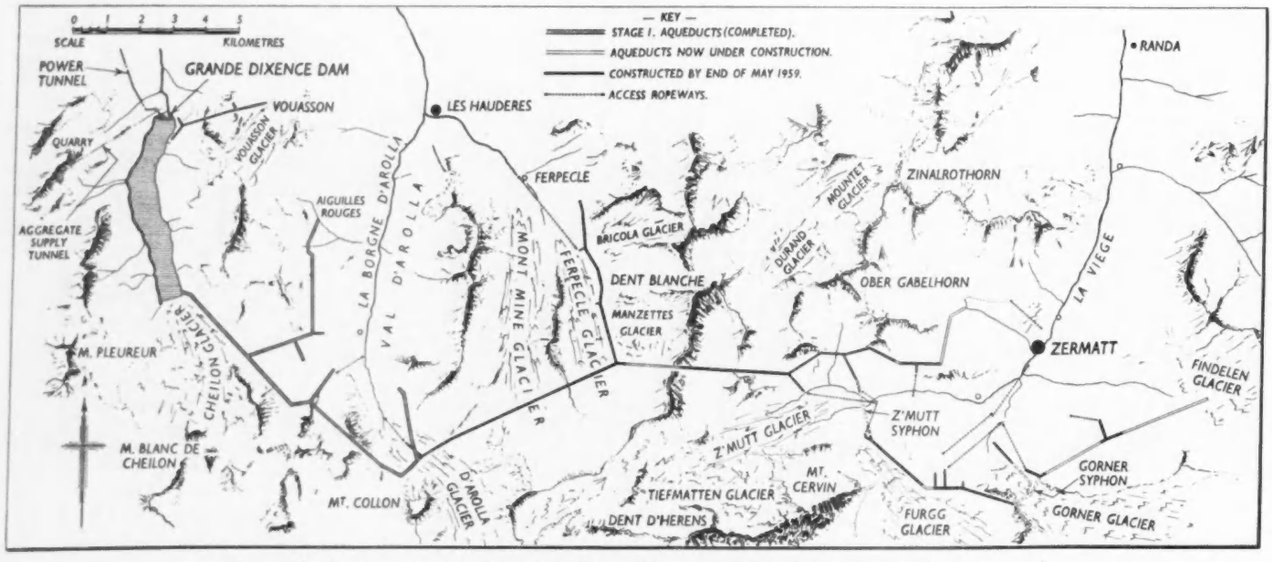
The characteristics of the largest contemporary water power schemes in the Swiss Alps exhibit several points in common. The first requirement is a site for a large storage reservoir at a high altitude—perhaps 2000m or more above sea level. Run-off from a vast area is then fed into this reservoir, either by aqueducts flowing into it by gravity, or by pumping stations serving streams or aqueducts lower down. Then power generation is achieved in several stages from the reservoir, down the river valley to the lowland valley, perhaps with pumping sets in the first stage below the reservoir. The reservoir is large enough to store perhaps a whole year's run-off. But at this altitude it is the summer snow-melt, largely in June and July, which is of greatest importance. Since the international boundaries generally follow the lines between mountain peaks, these schemes may involve international co-operation.

In recent years Swiss hydro-electric engineering has been dominated by one vast scheme of this kind—the Grande Dixence scheme—which in magnitude, and in some other respects too, is unparalleled ; it is given further attention below. Now it is planned to utilise the headwaters of the Rhine in two projects, each of comparable magnitude to the Grande Dixence. Work on one of them—the Hinterrhein scheme—has been in progress since last year and this scheme also is briefly described. The second project, the Vorderrhein, is envisaged in several stages and in its entirety is the largest of the three ; some first stage works of this scheme are under construction and are due for completion in about two years' time. Table II lists recent major schemes and projects receiving serious consideration.

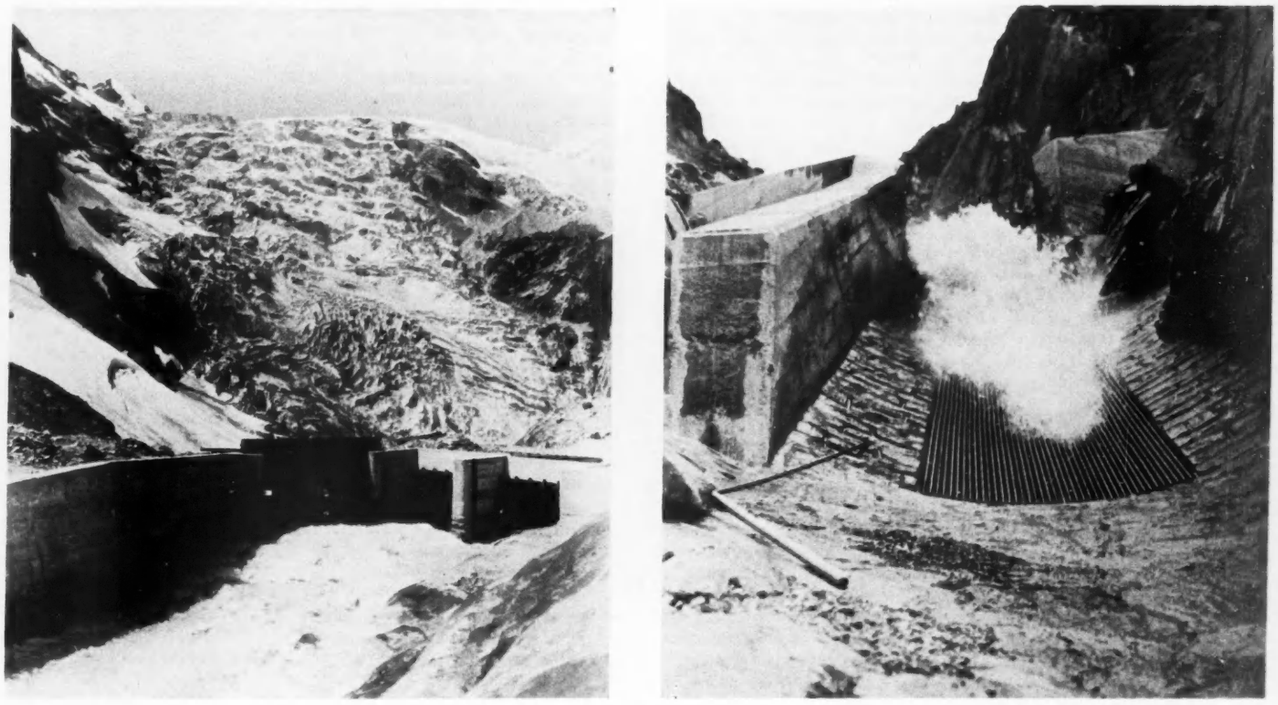
For a more complete picture of Swiss water power, we would refer the reader to the series "Some Recent Swiss Hydro-Electric Schemes" published in THE ENGINEER of April 9–26 and May 14–June 25, 1954. However, it will be evident that even since that time, the rate of progress has accelerated, so we cannot hope to review all the important technical aspects of present-day schemes in the brief space of this supplement. Before going on to these matters, however, mention is made of the two hydro-electric stations which members of the "Mechanicals" will be visiting.

INNERTKIRCHEN AND ALTENDORF POWER STATIONS

The best of modern practices in Swiss hydro-electric engineering will not be seen at either of these two power stations, since they are both a number of years old, and



Constructional progress to the end of May, with the high-level aqueducts feeding Grande Dixence reservoir



Typical intake works of the high-level aqueduct system serving Grande Dixence reservoir

progress in this field has since been rapid. Nevertheless, there are points of special interest in both of them.

Innertkirchen is the principal station of the Oberhasli company's hydro-electric system in the Aare valley and the Grimsel pass. It is the lowest station of the system, and takes water through an exceptionally long tunnel from the two Handeck stations, above which the reservoir works are disposed. It is of special interest as being probably the prototype of the post-war trend to build power stations underground. Innertkirchen power station was, in fact, built during the war and completed in 1943, and in a comprehensive series of articles published at that time* we pointed out in our description of the station that the decision to build it underground had been taken as much for reasons of economy as for reasons of security; figures were given to support this statement.

The power station—it is illustrated at the head of page 10—has vertical-shaft Pelton-wheel-driven generating sets installed in it, there being five sets, each of 52·25MVA, operating under a gross head of 672m. The average annual output of power from Innertkirchen is 620 million kWh—that is, nearly half the total output of the Oberhasli company's chain of stations. However, the proportion of summer generation is higher at Innertkirchen than for the system as a whole, the respective percentages being about 60 and 50 respectively. More recent additions to the Oberhasli system were described in our 1954 series referred to earlier.

Altendorf power station of the Etzel scheme has also been described quite fully in this journal.† The special interest here is that the Etzel scheme is an early example of the large-scale use of pumped storage in hydro-electric engineering, a trend which is now growing in importance. Under conditions such as those of Switzerland, pumped storage must prove itself economically advantageous compared against the construction of high-level aqueduct systems or reservoirs of increased capacity, which are the only alternatives for meeting peak loads, whether seasonal or daily. In this country, a pumped storage scheme must compare economically against steam generation as an alternative, but the advent of nuclear stations has enhanced the value of pumped storage. Thus the experience gained at Etzel and the design of the station should prove of great interest at the present time. The various works mentioned in this brief hydro-electric review can be found by reference to the map on page 2. Altendorf power station is not marked, but is beside Lake Zürich; the reservoir of the scheme is Lake Sihl, which is close to Einsiedeln, a town which is marked.

TABLE I—*Statistics of Swiss Electricity Supply*

Production for the year 1956/57 :	
Hydro-electric	15,704 × 10⁶kWh
Thermal	190
Imports	1,255
Total	17,149
Consumption for the year 1956/57 :	
Consumption	13,282 × 10⁶kWh
Losses and pumping	1,958
Export	1,909
Total	17,149

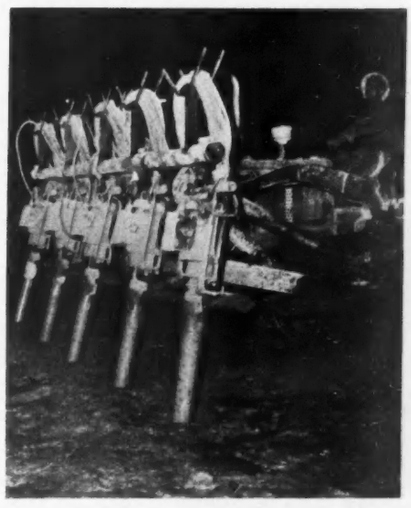
Hydro-electric power stations	1957	1962
Installed capacity, MW	4,131	7,308
Mean production, kWh × 10⁶ :		
Summer	8,922	12,091
Winter	7,750	12,151
	(46·2 per cent)	(50·1 per cent)
Annual	16,672	24,242

Storage reservoirs :	
Energy equivalent of water in storage reservoirs on September 30, 1957	2,363 × 10⁶kWh
Percentage of storage capacity filled on September 30, 1957	85
Energy equivalent of water in storage reservoirs on April 21/28, 1958	338 × 10⁶kWh

* THE ENGINEER, March 5 to April 16, 1943.
† See THE ENGINEER, February 22 and 29, 1952.

TABLE II—*Recent Water Power Developments of More Than 300MW Capacity*

	Installed capacity, MW	Power generation, kWh × 10⁶		Remarks
		Winter	Summer	
Grande Dixence	675	1460	237	To be completed in 1962
Hinterrhein	645	771	646	To be completed in 1963
Vorderrhein Stage 1	285	427	373	Power generation in 1961
Vorderrhein Stage 2	616	1021	847	Project only
Emosson	521	588	49	Not finalised. Franco-Swiss negotiations in progress
Engadine	376	657	693	Construction will probably start in 1962
Blenio	404	488	493	Partly under construction
Linth-Limmern	302	258	96	Completion scheduled for 1962
Mauvoisin	352	604	157	In full operation



Tractor-mounted immersion vibrator rig consolidating concrete at Grande Dixence dam

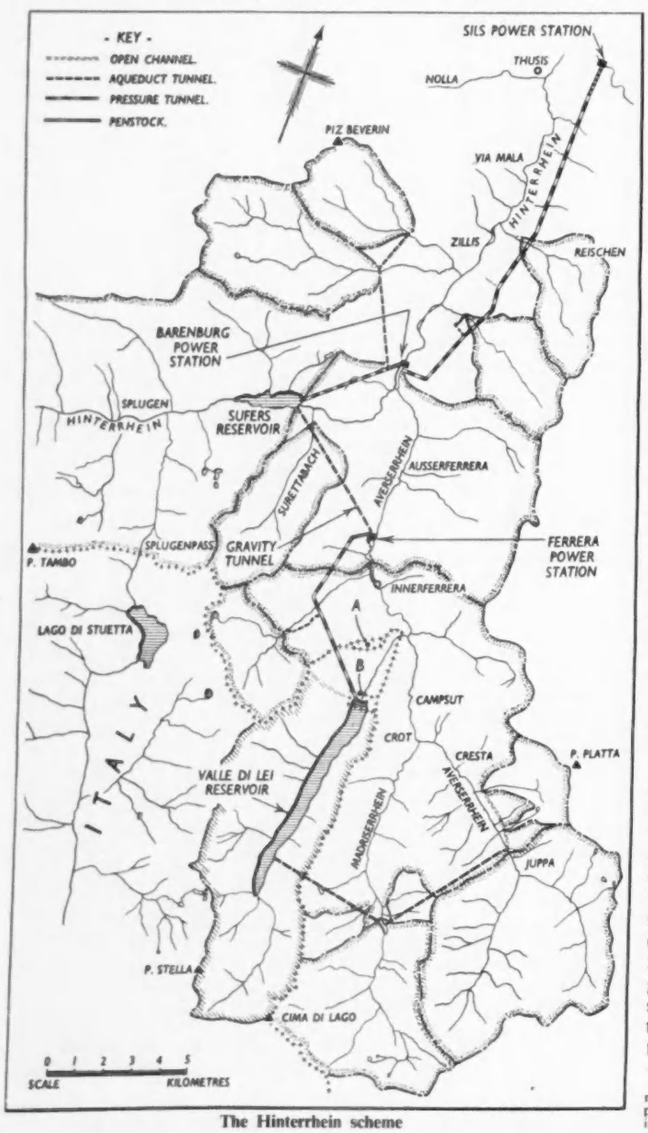
There are six pumping and generating sets in the Altendorf station. The gross head is 483m, which has necessitated the use of five-stage centrifugal pumps. Each set, therefore, consists of a five-stage pump, a Pelton turbine, and a motor/generator, arranged with a vertical shaft layout. The pump is at the base, and is engaged with the set by a friction clutch. The clutch can be engaged or disengaged only with the pump out of operation. The motor/generator of each set is of 18MVA capacity. The nominal rating for each pump is 21,450 metric h.p. input at a discharge head of 1561ft, a delivery of 38,165 g.p.m., and an efficiency of 85·6 per cent. Three of the sets supply power to the Swiss Federal Railways, and three to the grid of the Nordostschweizerische Kraftwerke A.G.

Grande Dixence Scheme

A full description of the Grande Dixence scheme cannot be given in the compass of this supplement, so the following information relates to constructional progress up to the present, and to the three major changes in the design of the scheme since we described it in our 1954 series of articles already referred to. The point of special interest in the scheme is the extremely high proportion of winter power it will yield, which in its turn, depends on the construction of the highest dam the world has yet seen—it will be 922ft high—situated at an altitude of 7750ft (top water level) above sea level, and supplied by aqueducts totalling about 100km in length, built high in the mountains, some just above the top water level of the reservoir, but some slightly lower down and depending on pumping. The storage capacity of the completed reservoir will be about 400 million cubic metres (about 325,000 acre-feet) and the mean annual inflow only slightly greater than this figure.

The Aqueducts.—We illustrate two typical intakes of the Grande Dixence aqueduct system, and also a map showing recent progress in constructing the system. The Mauvoisin dam is situated in the adjoining valley to the west, and in the original scheme water was to be diverted from this catchment at the high level, and the Mauvoisin reservoir compensated by a pumped supply from an aqueduct system at 6260ft above sea level, extending as far as Zermatt, and catching the run-off between the two levels. Now, the aqueduct to the west of the Grande Dixence dam has been abandoned, leaving the Mauvoisin catchment to drain naturally, and the low level aqueduct has been modified to form separate branches feeding into the high level system at strategic points where pumping plant is to be installed.

The aqueducts shown on the map will eventually extend beyond Findelen along the right bank of the Viège to about the top of the map at the high level (2400m). A left-bank system will also be built beside the Viège at the lower level (2000m) and, at the same level, an aqueduct will be built from Ferpecle to the Val d'Arolla. With these exceptions, the aqueduct system is shown completely on the map.



The Hinterrhein scheme

The completed system will include about fifty intakes and five pumping stations with a total capacity of 220MW. When the scheme is in full operation, 284 million kWh will be consumed each summer in these pumping stations, and 7,800,000 kWh each winter. The intakes of the upper system will all have sand-removal channels with scour valves controlled automatically by counterweights and floats according to the quantity of solid material brought down by the torrent.

The Dam.—When concreting of the dam began to progress, it was found that about 800,000 cubic metres* of concrete could be placed in a summer season, as against the earlier estimate of 500,000. The programme was thus revised for completion of the dam in 1961, and for its subdivision into two structural stages instead of three. The revised programme is illustrated in the series of diagrams on page 13. The blocks J2 and C2 are built up as separate monoliths, and keyed to stage 1 by concreting the slots (the shape of which was determined after photo-elastic investigation) at the appropriate time, and when the reservoir is empty, so that the stress distribution of the second stage would approximate to that for single-stage construction.

The dam has been designed by classical methods for a gravity dam, taking account of the weight of the dam, the thrust of the impounded water, and the inertial loads of the dam and the impounded water, due to an earthquake. The following conditions were observed: with the reservoir full, compression on the upstream face to be greater than 85 per cent of the hydrostatic pressure at the depth considered; the line of resultant thrust to remain within the central two-thirds of the base of any section at the occurrence of an earthquake with the reservoir full under the combined loads of: the weight of the dam; inertial loads of the dam; hydrostatic thrust; and uplift pressure of 100 per cent at the upstream face.

The maximum stresses calculated for the dam, are 75 kg per square centimetre and 130 kg per square centimetre at the toe, neglecting and including respectively the earthquake loads. With the reservoir empty, the maximum stress is at the heel, and is 73 kg per square centimetre. Expressed in pounds per square inch, these three figures are respectively about 1070, 1850 and 1040.

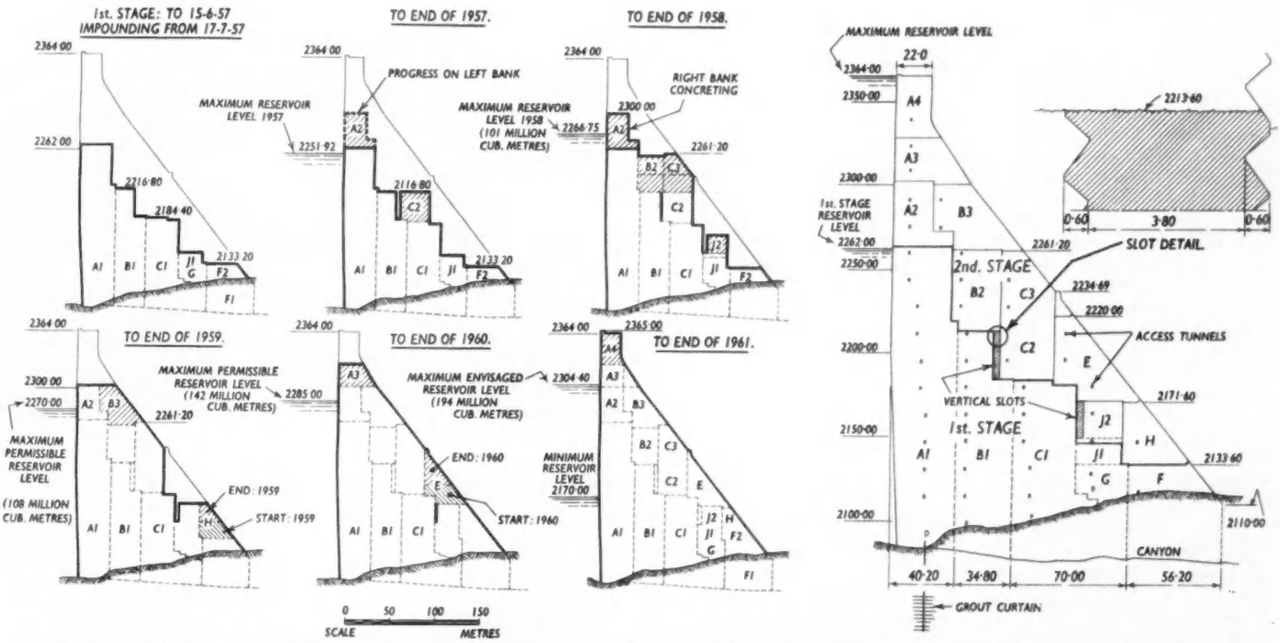
The illustration on the front cover of this supplement shows recent progress in the construction of the dam; the cableways and some of the constructional plant can be seen, and the slotted vertical faces between stage 1 and 2, and a small part of the finished downstream face, are particularly well shown.

The Power Stations.—At Fionnay, in the valley of the River Dranse, the underground stations of the Dixence and Mauvoisin schemes have been built on opposite sides of the river, with a complex arrangement of forebays and tunnels. The first stage of power generation of the new Grande Dixence scheme (the dam of an earlier scheme is submerged in the new reservoir, but the power station at Chandoline beside the Rhône at Sion, is still in use) is thus the Fionnay (Dixence) power station, where six generating sets are installed. Each one consists of two Pelton wheel turbines driving a three-phase alternator placed between them on a horizontal shaft, and has an output of 60MVA, i.e. a total installed capacity of about 336MW. The gross head range is 874/680m. The first three sets went into operation in 1957.

Here we come to the third major modification in the scheme. Two further stages of power generation were originally planned, with power stations at Sembrancher and Martigny, in the Dranse valley. Now, only one more stage will be built, following the route shown approximately in the map on page 2, from Fionnay to the Rhône, where a large power station at Nendaz will generate all the power of the second and last generating stage of the scheme. Thus approximately parallel, but independent, routes are taken from the Fionnay power stations of both Mauvoisin and Dixence schemes, to power stations beside the Rhône.

The Nendaz power station will be served by a tunnel from Fionnay over 16km in length. It is being constructed underground, and will contain six turbo-alternator sets, again arranged with horizontal shafts, and two Pelton turbines per shaft. The gross head on the turbines will be 1008/1002m, and the

* Over a 1,000,000 cubic metres of concrete was in fact placed in the dam in the 150 working days of the 1957 season.



Concreting procedure for the Grande Dixence dam. The right-hand drawing shows the modified programme which divides the concreting into two separate stages. Note the positions of the vertical slots, the form of which is shown in the inset. The series of diagrams to the left show progress of concreting

installed capacity of each of the six sets 80MVA. Power generation from the first sets is expected at about the end of this year. The cost of the entire Grande Dixence scheme is estimated to be 1400 million Swiss francs (over £120 million).

Hinterrhein Scheme

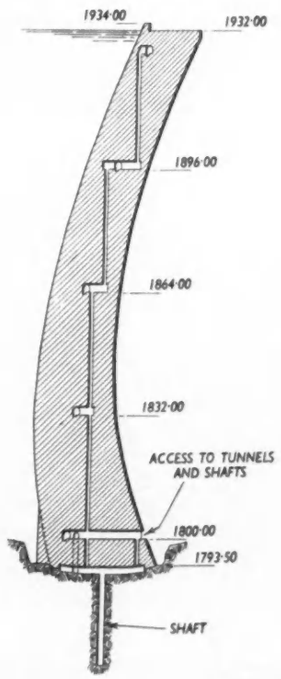
The Hinterrhein scheme illustrates a point made earlier that the scope of contemporary Alpine water power schemes is so large that international agreement is often necessary before they can be built. The reservoir of the scheme is in Italy, as is the direct catchment of the reservoir. The diverted catchments are, however, all Swiss, and the power stations are in Swiss territory, as the accompanying map shows. The Italian interest in the scheme is to the extent of 20 per cent, and the Italian electricity undertaking Società Edison participates, also to the extent of 20 per cent, in the consortium of firms, all the rest of which are Swiss, which have formed the controlling company Kraftwerke Hinterrhein A.G.

The scheme is being built in rather inaccessible areas, and the dam is, in fact, reached by a road tunnel—specially constructed as part of an extensive preliminary programme of road building—from the Swiss side of the border. On completion of the dam, the parcel of land containing it, marked *B* on the map, will be ceded to Switzerland ; in return, a similar parcel *A* will be ceded to Italy.

The top water level of the reservoir will be 1931m above sea level ; its direct catchment is 46·5 square kilometres in extent, but the aqueducts shown on the map will add a further 80 square kilometres, and run-off from a further 10·8 square kilometres area will be picked up at a side stream intake to the first tunnel. In all, 93 to 95 per cent of the available run-off will be picked up by the various aqueduct systems, it is estimated. The hydrology of the scheme is, in fact, well documented, observations of flow having been taken on the principal streams over the period 1921–53.

Ferrera power station will have 42MW of pumping capacity, and will, in summer, pump from the small Innerferrera reservoir, which drains a catchment of just over 80 square kilometres, up to the main reservoir of Valle di Lei. The useful capacity of the main reservoir will be 197 million cubic metres (i.e. about 160,000 acre-feet). The mean annual inflow is made up of about a third from the direct catchment, a third from the aqueducts, and a third by pumping. The reservoir capacity is about equal to two-thirds of this total inflow. The dam is illustrated in cross section ; it is an arch dam of very similar cross-sectional shape to the Mauvoisin dam, and will have a maximum height of 138m.

Valle di Lei dam is founded at a favourable site where the bedrock is paragneiss. Design of the dam consisted of an approximate " trial load " analysis, then a more exact analysis by the same method but using an electronic computer. The results thus obtained were verified by tests with a $^{1}/_{66}$-scale structural model. Much of the constructional material for the dam is transported along a route in Italy, and cement is brought to the site by a ropeway, 14 km in length, also from the Italian side. Concrete is being placed principally by cableways, there being plant with a capacity for mixing 240 cubic metres per hour installed at the site.



Vertical section through Valle Di Lei dam

Ferrera power station will be underground, and, in addition to the pumping capacity already mentioned, will have three horizontal-shaft Francis turbine generating sets totalling 185MW at a net head of 474m installed in it. The maximum gross head on these machines will be 525m, which is at present, we believe, unequalled for a Francis machine. The Francis turbines of the Fionnay (Mauvoisin) power station are at present the leading ones in this respect ; their maximum gross head is 472·5m. The two pumps to be installed at Ferrera will each have a power input of 20·8MW, corresponding to a total delivery of 8 cumecs against 464m head.

A free-flow tunnel will lead from the tail-race of Ferrera power station to the reservoir at Sufers (capacity $18{\cdot}3 \times 10^6$ cubic metres, top water level 1401m), where the run-off from the uppermost region of the catchment of the Hinterrhein itself, totalling about 200 square kilometres, is brought into the scheme. Below Sufers reservoir two stages of power generation complete the scheme, each with additional catchments, of 32 and 74 square kilometres respectively, adding their run-off to the flow available, through side-stream intakes to the main tunnels.

These two stages of power generation correspond to Barenburg and Sils power stations, where the respective installed capacities will be 225MW and 235MW, gross heads 321m and 413m, and mean annual outputs of power 487 million and 663 million kWh, of which 48 and 43 per cent respectively will be winter power. There will be four vertical-shaft Francis sets in each of these two stations.

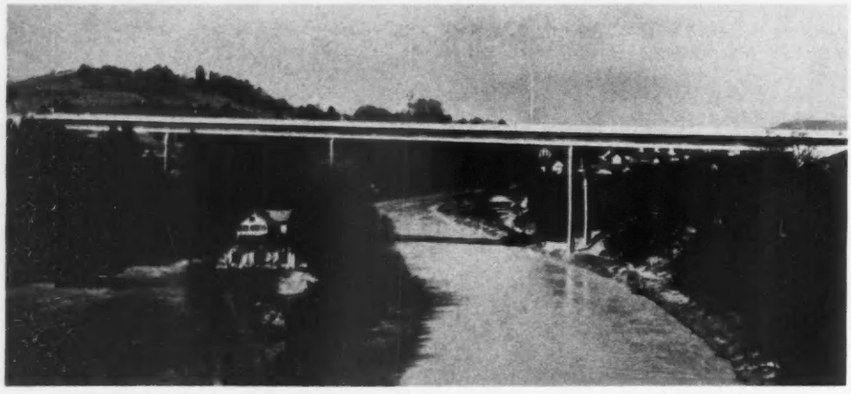
It is planned that power will be generated at the Sils station by the middle of 1961, and the whole scheme will be complete by the middle of 1963, for an estimated cost of 600 million Swiss francs (i.e. about £50,000,000).

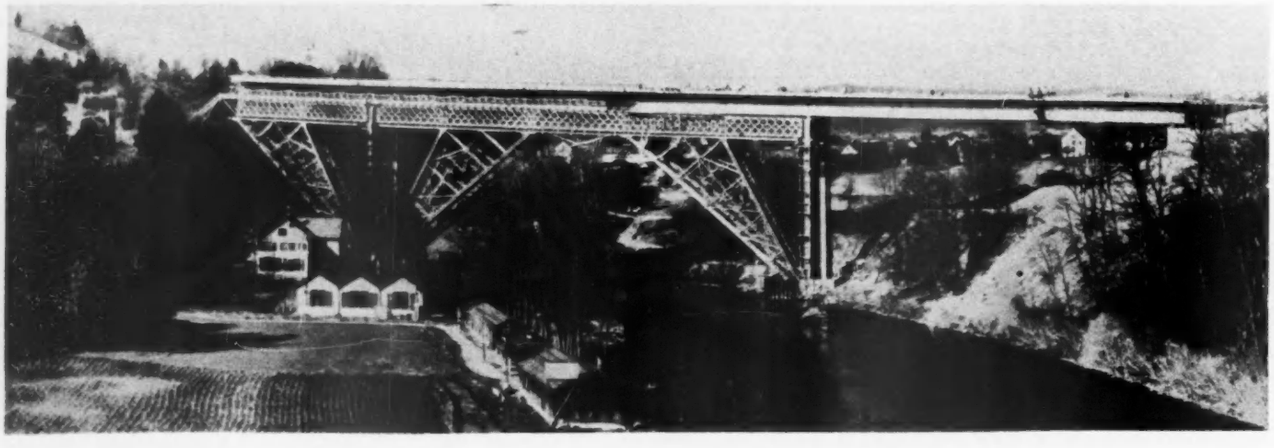
Concrete Bridges

Many elegant concrete bridges have been built in the Swiss valleys, the principal constructional material of recent years being concrete. The railway bridge (RIGHT) is the Lorraine Bridge over the River Aare at Berne, built in the period 1937–42. The span of the arch is 150m, the height 33·1m above the supports, and the thickness at the crown 3·2m. The bridge and its approaches comprise fifty-six spans, totalling 1150m, which makes this four-track viaduct the longest in Switzerland ; it required 70,000 cubic metres of concrete and 6000 tons of reinforcement for its construction.

The Swiss engineer, Robert Maillart, built his first reinforced concrete bridges almost sixty years ago, to designs which were strikingly unorthodox, and have since been recognised for their elegance and structural éclat. The bridge over the Thur at Felsegg (LEFT) is one of his later works and was completed in 1933, but it is one which Maillart considered to be a strictly logical structural form. The bridge is a three-pinned arch, designed for heavy highway loading ; the shape of the arch in elevation reproduces the geometry of the envelope of resultant thrusts for various combinations of dead and live loads.

The Weinland highway bridge is one of the most ambitious prestressed concrete structures in Switzerland. The illustration (BELOW LEFT) well shows its slender form. The bridge is continuous over four spans of 66m, 88m, 76m and 57m respectively, and in cross-section consists of three beams, each 4m deep and 0·5m wide (1m wide at the supports) interconnected by a haunched deck slab 20cm thick, extending over the 16·5m width of the bridge. The structural weight is 30 tons per lineal metre. Special problems were presented in designing the centering for the bridge, since the river channel could not be impeded ; the LOWER illustration shows the bridge under construction, and the centering in use. Design of this temporary work was almost as big a task as the design of the permanent structure. The constructional scheme was based on three stages, allowing re-use of the centering, and a 4·5-ton cableway spanning the site. The centering included special "inching" devices for slowly raising or lowering the completed assembly.





Some Major Engineering Firms

THE works selected for visits by members of the Institution cover a representative range of the Swiss engineering industry, and include those of several firms whose names have long been well known to British engineers. The works to be seen will include several which have grown with the passage of time on sites where their founders started small businesses, in some cases more than a hundred years ago. These works, like similar establishments in this country, often suffer from space restrictions and they offer a sharp contrast to the many excellent new factories opened in more recent years. The new works, and the considerable extent to which many of the older ones have been rebuilt and re-equipped, indicate the high degree of prosperity which the Swiss engineering industry has experienced for several years. Practically all of the firms which will be seen have ploughed back considerable sums of money in rebuilding, extensions and new equipment, and some interesting programmes are still in progress in this connection.

Probably, together with this practice of ploughing back capital for expansion and to take full advantage of the latest methods, the investment of large sums in research and development has been equally responsible for the success of the engineering industry in Switzerland. All firms, large and small, seem to maintain a research section staffed by specialists which generally works quite apart from the production sections. Some of the bigger firms have laboratories which must be amongst the largest and best-equipped in Europe, and they usually work in close collaboration with well-organised development sections. This work of research and development of new techniques and processes is well supported in all production departments in Swiss factories where a noticeable amount of attention is paid to detail, and to the maintenance of the highest standards of craftsmanship and finish.

Amongst the noteworthy features of Swiss factories is the attention which is given to cleanliness and orderliness by managements. In this connection it is evident on every hand that employees co-operate wholeheartedly with managements in maintaining standards which concern their welfare and safety. No doubt it is this appreciation and interest on the part of workers that has prompted the setting-up of very fine amenities blocks and the provision of first-class canteen facilities in a majority of the establishments.

The training of apprentices to ensure an adequate supply of craftsmen in the future is taken very seriously in all works, and most have a well-equipped training school for teaching both the theoretical and practical side of engineering. Initial training is carried out by skilled instructors and teachers, and generally when the boys go out into the shops they work with selected operatives in the different sections. From conversations with those concerned with training, it is evident that boys take their training very seriously and high standards of technical ability and craftsmanship are expected of them. We recently had an instance of the enthusiasm of apprentices when we accidentally wandered unaccompanied and unannounced into a training machine shop. No instructors were present at the time, yet every boy was fully engaged and it was necessary to stop one at his work to obtain the required directions. Perhaps we chose an opportune moment, but it did not appear so at the time.

In the descriptions of individual works which follow, we have endeavoured to give a brief outline of the background and products of a number of the engineering firms to be visited. It must be pointed out, however, that there are many more points of interest in each factory than those we have recorded for, of necessity, we have had to limit the space devoted to each firm in this supplement. It will be seen that in some cases fuller particulars have been given on a work's facilities and production methods than on actual products, whilst in other cases products take precedence over the works. This does not in any way indicate that one is more important than the other—the choice has been made from the angle of visitors' interest and in view of the relatively short time which will be spent in each establishment.

Sulzer Brothers, Winterthur

Oberwinterthur works of Sulzer Brothers

Although the official history of Sulzer Brothers, Ltd., of Winterthur, is stated to date from 1834, the origin of the firm can be traced back in actual fact to 1775, when Salomon Sulzer opened a small brass foundry in the town moat—the only site made available to him by the local inhabitants at that time. In the years that followed, the fortunes of the enterprise fluctuated considerably but as the result of a decline in trade in 1805 business became insufficient to support Salomon Sulzer and his family, so he transferred it to his son Jakob and emigrated. Thereafter the business flourished under Jakob and his two sons, Johann Jakob and Salomon, and in April, 1834, a piece of meadowland in the town meadows was acquired for the setting up of the foundry and turning shops from which the enterprise has grown. This original foundry building still stands within the yard of the main works and is now used as a lecture theatre and reception hall. From these small beginnings the firm has grown to its present size, where it controls works premises covering an area of 62 acres on sites totalling some 215 acres in Winterthur, Oberwinterthur, Bülach and Solothurn. It now provides employment for no less than 10,500 people in Switzerland, and a further 5000 in affiliated companies in other countries. Its wide range of products includes diesel engines, compressors, gas turbines, pumps, boiler plants, refrigeration equipment and heating and ventilating plants, as well as some 30,000 tons of iron and steel castings a year. In more recent years, the firm became interested in textile machines and developed the Sulzer weaving machine, which is now made in large numbers in a factory at Soleure.

In the relatively brief time the members will spend at the older works at Winterthur and the new works at Oberwinterthur they will only have time to get the barest impression of the size and variety of products made by the company.

The main Winterthur works, in addition to the shops engaged in the manufacture and assembly of large and medium diesel engines also embrace the main plate fabrication, welding, machine and general production shops serving the departments concerned with the manufacture of hydro-electric equipment, process, steam and other plant. A large laboratory building associated with works material control, development and research includes well-equipped physical, chemical, metallurgical and heat laboratories, with a heavy materials testing section on the ground floor. Diesel engine research has always taken an important place in research programmes, and for this work there is a separate laboratory and test rooms.

A majority of the engines to be seen under

construction in this works are of the large two-stroke marine type and the range of medium rating, two-stroke, trunk-piston engines for marine and power generation applications. In recent years the firm has developed new designs of welded two-stroke marine engines with exhaust turbo-charging, suitable for operation on heavy fuel oils. The latest type is built with two bores, i.e. 760mm and 900mm, and can have from five to twelve cylinders, each cylinder having a normal output of 1300 b.h.p. or 1835 b.h.p. respectively. When the visitors are shown the heavy engine assembly and test bay they will see in course of erection one of the largest of these "RD 76" engines. This turbo-charged, two-stroke engine has six cylinders of 760mm bore and 1550mm stroke, and it develops 7800 b.h.p. at 120 r.p.m. At present there is in course of design the largest engine of the series, which has twelve cylinders and develops 16,000 b.h.p. These engines have exhaust-driven turbo-chargers which operate on the pulse system, their speed changing in accordance with the load on the engine.

In addition to this large engine a selection of other engines will be in various stages of erection and under test, and it will be possible to inspect examples of welded construction now being widely used side-by-side with the hitherto familiar cast iron form of crankcase and bed-plate design. One corner of the test shop with a large diesel engine undergoing test is shown below.

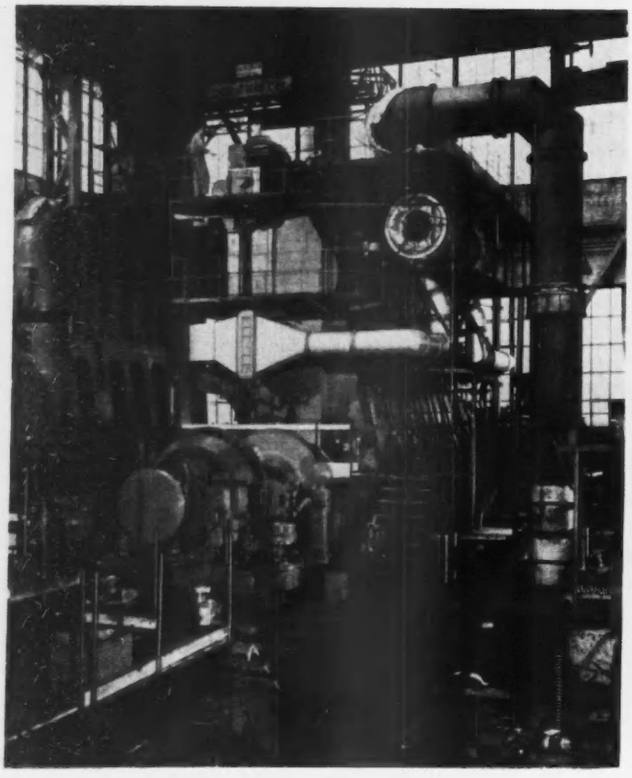
As is the case with other large firms in Switzerland, the site available at the main works of Sulzer in Winterthur has been fully developed, and early this century a new site was acquired at Oberwinterthur to provide the required space for extensions to meet the demands for increased production. On this new site there have been built to date a new foundry, 720ft long by 485ft wide, a general machining and assembly shop and a two-bay heavy machining shop 560ft by 230ft.

The general machining and assembly shop is concerned with the manufacture and assembly of the smaller sizes of oil engines, pumps, compressors, gas turbines and other plant. The general flow of production is arranged across the width of the main building, the work passing from the machining lines to the sub-assembly and on to final assembly sections. In the engine sections of this shop there are to be seen in course of manufacture and undergoing test a number of the engines being made by Sulzer for installation in the diesel-electric locomotives for British Railways.

Heavy machining bay of new machine shop

The foundry which was completed last year is capable of producing castings weighing up to 120 tons and it now has an annual production of about 24,000 tons of steel and iron castings. Steel castings are made in two of the bays served by three arc furnaces of 3 to 14 tons capacity and six medium frequency induction furnaces of ½ to 10 tons capacity. The other four bays producing iron castings are supplied with metal from two hot blast cupolas with a melting capacity of 12 tons an hour. A preparation plant at one end of the building supplies sand to all parts by a conveyor system, and there is also a central core making section. All production is highly mechanised and amongst the equipment of interest to be seen in the iron foundry section is the plant shown below. This comprises a four-station indexing table at the first station of which the mould box with its pattern plate are set on a roller platform. At the next station the facing sand is deposited from the end of a belt carried on a hand-controlled swivelling jib and fed from an overhead hopper. When the box is indexed to the third station it registers below a sand slinger, which, under remote control from a platform at the rear, deposits the backing sand. At the final station the box is rolled out on to the table of a jolt squeeze machine in which the pattern is withdrawn and the mould passed out to a roller conveyor for coring. Alternate drags and copes are made on the machine and the copes are placed on the cored drags as they come off the jolt squeeze machine.

In the heavy moulding section of the shop a line of casting pits is served by a



Diesel engine on the test stand

Four-station mould machine in mechanised foundry

rail-mounted sand slinging machine. Enclosures containing knock-out and casting dressing stations are situated at various positions round the main moulding points and these enclosures are provided with dust extraction and water spray equipment. In addition to a range of shot blasting plants a large high-pressure water jet chamber is provided for cleaning the heavier castings made in the foundry. A central laboratory is responsible for quality control throughout the foundry and is fully equipped for chemical and physical testing of the sand, raw materials and melts.

An impression of the size of the new machining shop for heavy work which has recently been placed in service can be obtained from the top illustration on page 16, which shows the bay which is equipped for the heavier classes of what might be generally termed "flat" work involving the use of planing, milling, radial drilling and horizontal boring machines. The other bay is concerned with the manufacture of crankshafts, cylinder liners and pistons.

There is at present being installed in the heavy bay the plano-milling machine made by Schiess A.G. of Düsseldorf, described in our issue of January 23 last. This machine, which weighs some 900 tonnes, has two tables, one 28ft and the other 35ft long on its 151ft long bed. It is capable of machining workpieces 15ft square and weighing up to 150 tonnes mounted on either of its tables or with both coupled together for supporting long components. When it is remembered that the firm also has a vertical lathe with a 20ft diameter table taking work 15ft high and weighing up to 50 tonnes, the impressive machining capacity available in this works can be appreciated.

The size and weight of the workpieces machined in the heavy bay call for an effective installation of cranes for speedy and efficient handling to reduce to a minimum the idle machine time normally involved in repositioning, setting and removing work. For this reason two systems of overhead cranes, one above the other, have been installed to serve the full length of the bay. One pair of cranes, each of 125 tons capacity, are carried on rails at 57ft above floor level and the second set of rails, 41ft above floor level, carry two 40-ton cranes. In the other bay of the shop where the work handled is generally of a lighter nature there are two 25-ton overhead cranes serving the full length. These cranes are carried on rails 41ft above floor level, and their services are supplemented by 10 tons capacity travelling jib cranes which are supported on rails mounted some 20ft above floor level along each side wall of the bay.

In very large shops of this kind much productive time can be lost by a machine operator in waiting for assistance or crane service, and to avoid this form of wastage a special light signalling system has been introduced. Above each machine, and visible for the full length of the bay, there is situated a square box in each side of which are four colour lights. By switching on the appropriate lights an operator can indicate, without leaving his machine, that he requires the services of the shop foreman, an inspector, a labourer or a crane.

The normal amenities block is replaced in this works by a system of underground halls built below a main roadway. These spacious, well-lit halls contain toilets, wash rooms, baths and changing rooms for the employees. By the introduction of this underground system a large area suitable for factory buildings has been saved, and an underground shelter system in the event of a war provided.

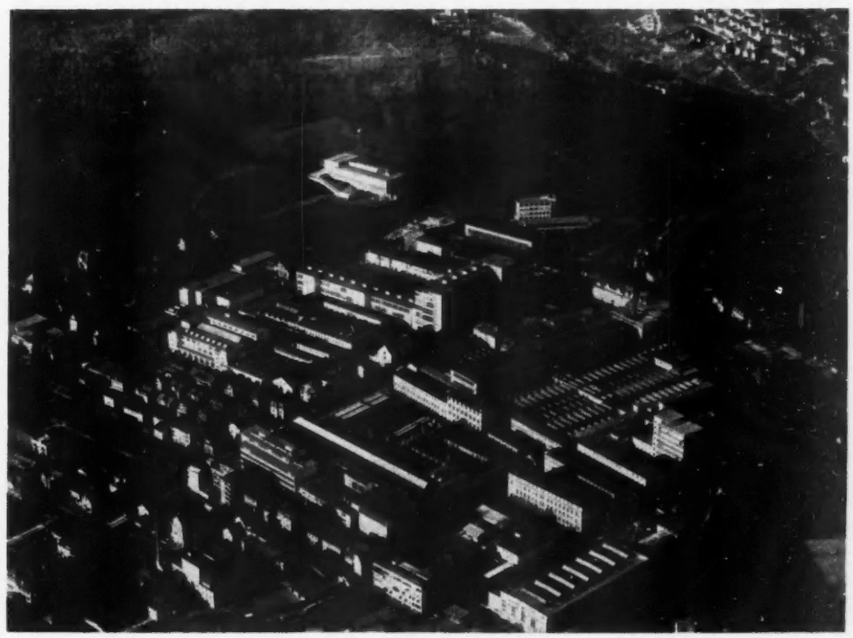
Brown, Boveri & Cie, Baden

Founded in Baden in October, 1891, by Charles E. L. Brown (1863–1924) and Walter Boveri (1865–1924), the Brown, Boveri Company is one of the leading electrical enterprises. On March 31, 1959, there were 9618 workers and 3365 employees at the Baden works alone, together with over 40,000 people employed in fourteen Swiss and foreign subsidiary companies and over seventy technical bureaux and agencies throughout the world. About 80 per cent of production is exported.

C. E. L. Brown first became internationally known through his three-phase, 25kV transmission over 175km from Lauffen on the Neckar to Frankfurt-on-Main, built for the Frankfurt Electrical Exhibition of 1891, an achievement which decisively influenced the development of electric power. There followed the Heilmann thermo-electric locomotive, oil circuit breakers, the first main-line electrification in Switzerland, and generators for terminal voltages of 13·5kV. In 1901 was completed the first steam-turbine set on the Continent, at that time the world's largest—300kW at 3000 r.p.m.; the generator being fitted with the cylindrical rotor newly invented by Brown; 1903 saw the first continental marine turbine. When the 19·8km-long Simplon Tunnel was handed over to traffic in 1906, electric traction was provided between the end stations Brig and Iselle. In the same year began work on a combustion gas turbine, and, of more immediate importance, the application of turbo-blowers and compressors to blast-furnaces, later to Bessemer steel works and mines. In the years before the first world war fall the installation of the first single-phase railway generator for 16kV (1909), the Holzwarth gas turbine (1910) and the manufacture of mutators. Scavenge turbo-blowers for two-stroke diesel engines were introduced in 1916, and exhaust turbine-driven blowers in 1923. Of important later developments we mention the suppression of short-circuits and backfires in mutators by grid control (1926), and the first air-blast circuit breaker for 13kV (1933). By improving the efficiency and compression ratio of the axial flow compressor (1931), the way was opened for the industrial gas turbine (1937) and the first gas turbine alternator set of 4MW (1939), as well as the gas turbine locomotive (1940). Since those days, sixty-five gas turbine installations have been commissioned with capacities up to 27·5MW for a double-shaft unit, nineteen of them—mostly blast-furnace gas fired—for inlet gas temperatures of 750 deg. Cent.

In 1931 began the manufacture of turbine rotors by weld fabrication from solid discs. Mention may also be made of the "Velox" forced circulation boiler, produced in 1932, and the water-jet electric boiler of 1935. A year later, the company entered the high-frequency field. The current rebuilding of the Vienna transmitter Bisamberg (4×120kW, with evaporation cooling of the transmitter valves) is the most recent development in this direction.

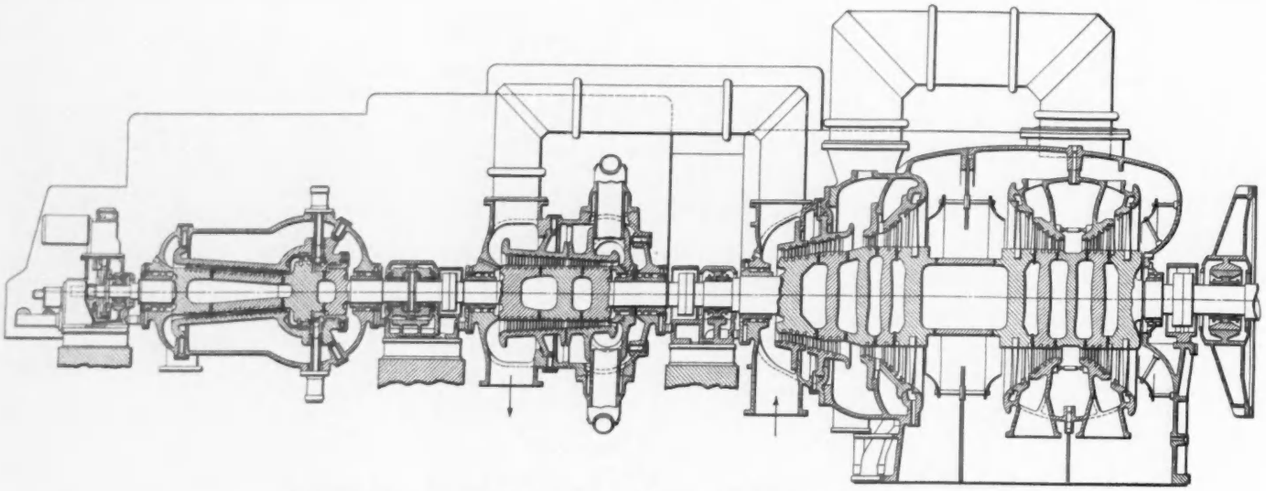
It is not possible to give here more than the briefest résumé of some of the principal achievements over nearly sixty-eight years. In passing, we mention the first main line locomotive without pony axles, rated at 4000 h.p. (1944), the introduction (in 1941) of the radial core and splay-flange insulation for transformers, as well as multiple-break e.h.t. air breakers, and the manufacture of 380kV transformers and switchgear which began in 1950.



Baden works of Brown, Boveri & Cie

Baden Factory

When activities began on October 1, 1891, the factory comprised three bays, the foundry, a store, and the caretaker's lodge—all still extant except the foundry—and three rooms rented as offices at an adjoining inn. The aerial view on this page, shows the present development. The site adjoins the main line to Brugg and Basle, and is divided into slightly unequal parts by the Brugg road, which is seen to continue parallel with the railway



Longitudinal section through a 175MW turbine showing the double-shell h.p. and i.p. cylinders

into the right background. In the near section along the Brugg road from left to right, are the multi-storey central laboratories, which stand on the site formerly occupied by the materials testing station ; the transformer factory and coil winding departments ; the engineering and turbine shops, and the fluid dynamics and combustion laboratories. Adjoining the central laboratories on the side towards the railway are housed the high-frequency and circuit breaker test bays and the high-voltage testing laboratory (taller building at end of block). The new central laboratories, which came into service last year, comprise chemistry, physics (including materials testing), and metallurgy sections. On its eight floors the building has a total floor space of 7360 square metres. The 3·5m high rooms have floors designed to support 500 kg per square metre (1000 kg per square metre in some cases), and are equipped with all services, including compressed air at 7 atmospheres and oil-free air at 1 atmosphere, also cold, hot and demineralised water, ventilation and drainage. A 31 MeV betatron is available for the radiographic examination of metal parts.

Test equipment at the Baden works includes high-voltage test installations for 1·6MV a.c., 1·2MV d.c., and 3·6MV impulse, while in the high-power laboratory generator capacity of 80MVA and transformers of 400kV furnish a symmetrical breaking power of 600MVA for circuit breaker tests. Lightning arresters may be subjected to surges of up to 12kA, 200kV, lasting from 30 to 1000 microseconds. The steam turbine test bed can be supplied with up to 60 tons per hour of steam at 34 atmospheres. Three remote-controlled, explosion-proof test pits enable rotors to be subjected to speeds of up to 75,000 r.p.m.

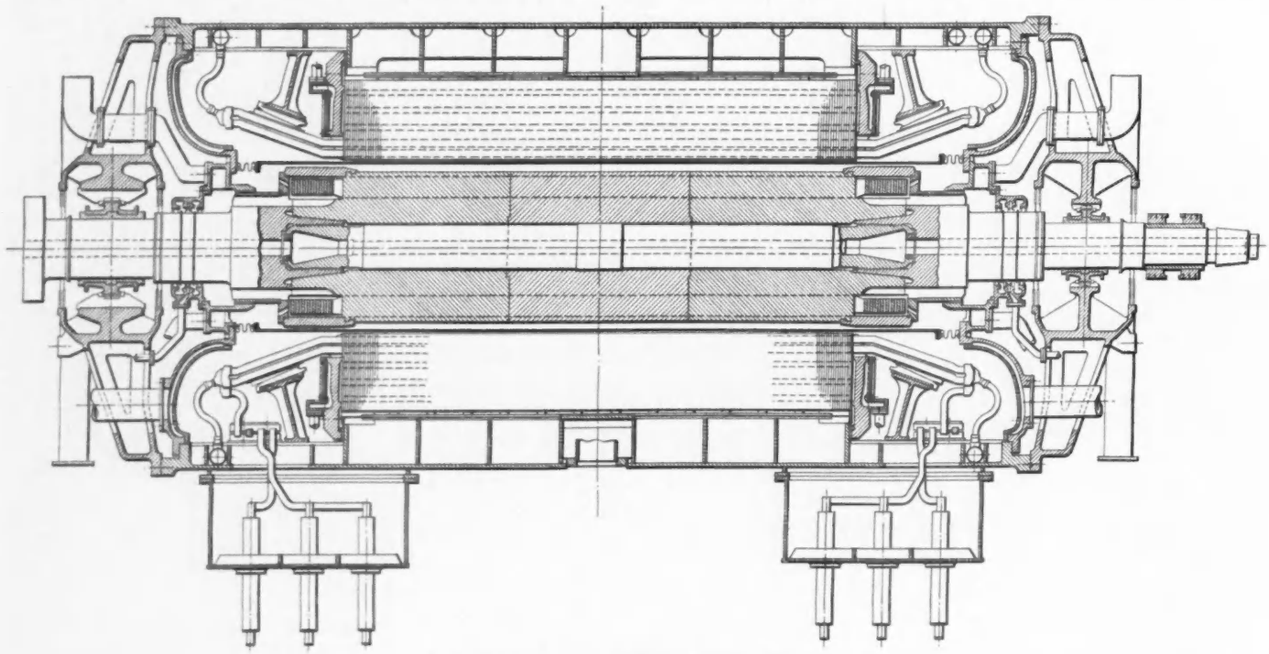
Because further expansion at the original site is impossible, the company is building a new plant at Birrfeld, south of Brugg (Aargau) to which heavy electrical construction will be transferred later this year.

Steam Turbines and Generators

Over 6000 steam turbines, with an aggregate rating in excess of 30,000MW, have been supplied for land installations, as well as a number of geared marine turbines and "Velox" boilers. This tendency towards larger units, 125MW and over, is continuing. Since 1955, two 150MW single-shaft sets, the largest built so far by Brown Boveri, have been installed at Frimmersdorf, near Cologne, and three similar units for the same station are on order. A still larger set of 175MW, destined for Amer III power station (Netherlands), is at present in process of construction.

While the two Frimmersdorf turbines are designed for 171 kg per square centimetre and 525/525 deg. Cent., the 175MW Amer turbine (shown above) is to operate at 171 kg to 180 kg per square centimetre, 565 deg. to 570 deg. Cent., with reheat to 540 deg. to 545 deg. Cent. Compared with the 150MW design, the triple-flow l.p. cylinder has been enlarged, and the valve chests placed at the side (as seen on page 19). To avoid scaling, the impulse blades had to be made of 12 per cent Cr steel.

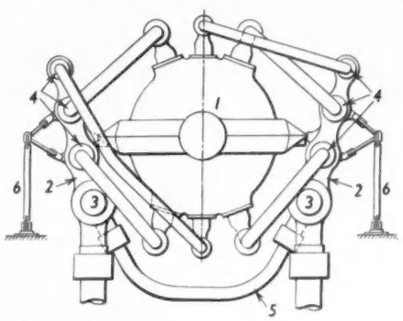
In the next few years, it is thought that the best compromise between high thermodynamic efficiency and low capital cost will result from inlet temperatures of 525 deg. to 565 deg. Cent., for which ferritic steels are still suitable, coupled with supercritical pressures. In co-operation with Sulzer Brothers, five variants of a 250MW power station were studied. The best fuel consumption, 2092 kcal per kilowatt-hour (overall efficiency=41·1 per cent), was shown by the



Sectional view of a 260MVA alternator

plant with the highest inlet conditions of 306 atmospheres and 600 deg. Cent. and with two reheats to 565 deg. Cent., which is 18 per cent dearer to build than the design with the lowest inlet conditions of 176 atmospheres, 525 deg. Cent. and single reheat to 525 deg. Cent., which has a specific fuel consumption of 2239 kcal per kilowatt-hour.

At the beginning of March, an order was received for two single-shaft, 230MW turbines and their generators for Haynes power station, Long Beach, Los Angeles, the first of these machines to be commissioned in 1962. Inlet conditions are given as 142 atmospheres, 538 deg. Cent., with reheat to the same temperature, and six-stage bleed-off feed heating to 246 deg. Cent. ; the condenser vacuum is to be 0·052 atmospheres (1·5in H_2O). The 40m long sets, each weighing about 750 tons, will be sited in the open. The three-phase, 60 c/s generators will be laid out for 270MVA, 18kV, and will have hydrogen cooling as well as oil cooling of the stator windings. On the opposite page we show such a generator for 260MVA. By using external blowers, the hydrogen velocity through the rotor is increased so that the necessary pressure can be kept down to about 2 atmospheres, instead of 5 or 6. Rotor and stator space are separated by a thin cylindrical partition, pressure-balanced by nitrogen on the outside. The rotor has a diameter of 1150mm and comprises three sections which are clamped together by a central tie bar. Larger generators up to about 500MVA can be built by using the same cross-section but increasing the length of the machine.



1—H.P. cylinder.
2—Valve chest.
3—Main stop valve.
4—Control valves.
5—Connecting pipe allowing the closure of one of the main stop valves to be checked when the machine is running.
6—Pivoted supports.

Arrangement of the inlet valves of the 175 MW turbine

Hydro-Electric Generators

An interesting rotor design has been adopted for the first time for the three generators for Motec power station which are laid out for 29MVA, cos=0·8, 750 r.p.m. The pole wheel body consists of six circular discs of which the two outer ones are of one piece with stub shafts. The assembly is held together by shrink-fitted axial bolts. By enabling the non-active centre to be made hollow, weight and cost are reduced. Among other large water generators which at present are on order are the three machines for Thierfehd power station, which are laid out for 100MVA, cos=0·8, 600 r.p.m. ; the Italian subsidiary, Tecnomasio Italiano Brown Boveri S.A., is delivering two 115MVA generators for Grosio power station. These machines have a power factor of 0·5 and a speed of 333·3 r.p.m. Finally, mention may be made of the four generators for Tokke power station. Designed for 120MVA each at 16kV, 50 c/s, cos=0·8, they will be driven by Kvaerner-Bruks Francis turbines of 145,000 h.p., 375 r.p.m.

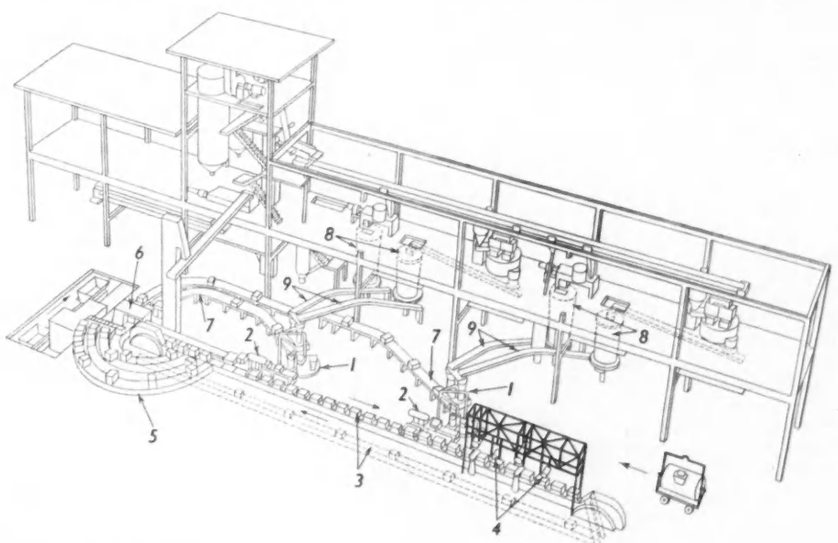
George Fischer, Ltd., Schaffhausen

The firm of George Fischer, Ltd., was founded in 1802 when Johann Conrad Fischer acquired a disused mill at Mühlenthal, on the outskirts of Schaffhausen and converted it to a melting shop for his first experiments in the manufacture of crucible cast steel. By 1804 he had attained successful results and from that time on the history of the company is one of widening interests and continuous expansion. In the space available it would be quite impossible to give more than the barest outline of the growth of the company, but it might be recorded that it began making malleable iron castings in 1828, steel castings in 1877, tube fittings in 1864. With the acquisition of the Rauschenbach Engineering Works in 1921 and the firm of Muller A.G. in 1941, the foundries of these two concerns vastly increased the capacity of the company for the manufacture of grey iron castings, and in the machine shops in the former firm's works the manufacture of the now so well-known rigid copying lathes was started in 1937. As a result of these developments the company is now one of the largest producers in Switzerland of malleable tube fittings and castings, steel castings weighing up to 50 tons, grey iron castings weighing up to 12 tons, and special alloy castings of all kinds. It should be pointed out that, in addition to making castings, the company provides facilities for their machining and large machine shops at Schaffhausen are equipped with a range of modern machine tools up to the largest capacities for this class of work. The finished products of the firm also include, in addition to machine tools, a variety of other equipment for the foundry, textile, transport and other industries.

Some ten years ago this company, which has been so closely associated with the progress and development of the iron and steel industry for more than 150 years, established a trust foundation for setting up what is now the world-famous "Iron Library" at the Paradies Estate near Schaffhausen. In this library visitors will see a unique collection of historical and contemporary literature on the mining, production and manufacture of iron and its infinite number of applications in the service of humanity. Nearly 19,000 books, some dating as far back as the thirteenth century, have been gathered in the library, which also has an extensive reference index of the material published on the subject in all parts of the world. This library provides an invaluable source of information on the subject of iron, and its facilities are available to research workers and students from all parts of the world.

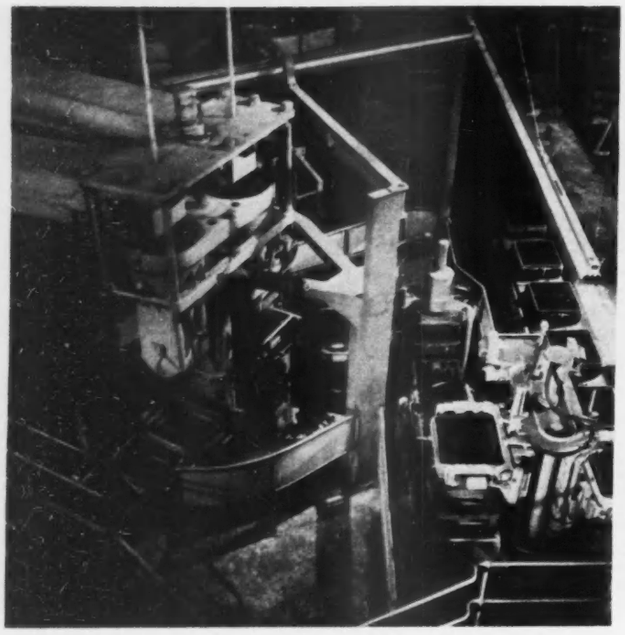
At present the works and foundries of the firm in the Schaffhausen district cover an area of some 400 acres and they provide employment for over 5000 people. As there was not sufficient room for expansion on the site where the main works now stand, part of a hillside has been removed to provide space for extensions to the shops. Although there is much well worth seeing in the various parts of the extensive foundries and shops the members of the Institution will not have sufficient time to get more than a general impression of some of the outstanding items, with some of which we will deal briefly. In the malleable iron foundry there is now in operation what is probably one of the most highly mechanised moulding plants in the world. This plant, the general layout of which is shown diagrammatically above, produces up to 300 moulds an hour. It is so organised that a complete change-over from one class of work to another can be made without need for stopping the flow of production.

The plant is served with metal from its own cupola installation and incorporates a complete automatic sand preparation plant. This sand preparation plant is installed on a floor above the main moulding plant, and from it the facing sand and the backing sand supplies for the two moulding stations is



1—Half mould making stations.
2—Half mould transfer tables.
3—Mould conveyor system with underfloor return and cooling line.
4—Mould filling stations.
5—Spiral elevator for cooled moulds.
6—Mould knock-out.
7—Mould box return conveyors.
8—Moulding sand supply bins.
9—Sand supply conveyors to half mould making stations.

Arrangement of automatic moulding line in malleable iron foundry



One of the moulding stations of the automatic line in the malleable iron foundry

Mould pouring stations of automatic section of malleable iron foundry

delivered by conveyors to a pair of storage hoppers at each station. As additional supplies of sand are required the service bins of the moulding station's scraper feed tables below the main hoppers rotate and deliver a controlled volume of sand to the service bins. One moulding station makes the copes, or upper halves, of the moulds and the other the drags, or lower halves, the cores being placed in the bottom halves as they travel along a conveyor system to the station making the upper halves. At each station the pattern plate is first set in position with the mould box as it moves along a roller conveyor to an indexing table. On the indexing table first the facing and then the backing sands are delivered in metered quantities into the box which is then swung off the table and squeezed and jolted on a turnover machine before transfer on to a platform whence the pattern plate is returned to the first station. The drags then pass along the conveyor where the cores are placed, and when it reaches the second station the copes, made in a similar way, are placed on them and loaded ready for pouring. One of these moulding stations can be seen above.

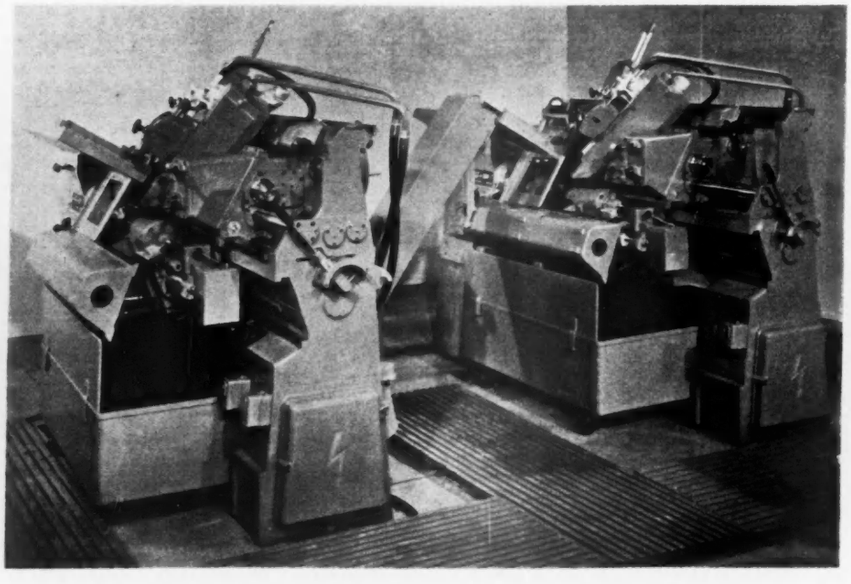
In the pouring section there are three stations at each of which a supply of molten metal is held in a main ladle of about 1 ton capacity. From the ladle at each station the required weight of metal for each mould is tapped into a small pouring flask which is suspended from a trolley running along overhead rails. Along these rails the pouring flask is traversed over a distance of about 9ft at the same speed as the mould conveyor moves. As each mould reaches its appropriate pouring station the traversing movement starts as the flask is tipped to deliver its contents into the mould. The speed of traverse is so timed that each flask has been emptied by the time it reaches the end of its movement. With the order followed at the three stations, two of which are illustrated (top right), pouring of one mould starts whilst another is in process of being poured and the flask of the third station is being re-charged.

From the pouring section the moulds pass down below floor level on to a conveyor in a cooling tunnel leading back to the far end of the line. At the end of the tunnel the moulds are delivered on to a spiral elevator leading to a knock-out. From this knock-out the boxes are returned to the moulding stations, the castings gravitate down a chute into a hopper and the sand is taken by a conveyor system back to the preparation plant. The castings are periodically tipped from their hopper into one of a train of slowly moving trucks on a closed circuit below floor level. By the time a truck has reached an unloading platform its contents are cool enough to be handled on a conveyor bench on to which they are tipped. Men on each side of this conveyor bench knock the castings off their grids which are returned to the bench at the end of which they are tipped into trucks for return to the smelting platforms.

The three hot blast cupolas serving this plant each have a smelting capacity of 7 tons per hour—one cupola being used to supply the metal for each working day. The loading platform has bins for the requisite materials along one side and the batches are made up in a weigh truck which traverses under power along the length of the bins. From the cupolas molten metal is delivered to the mould filling station in mobile rotary ladles.

The factory concerned with the manufacture of machine tools is primarily engaged in making the well-known "GF" copying lathe. Since this machine was first built, as it were, in a "closed frame" rigid form in 1937, it has been redesigned to its present construction and undergone considerable development to incorporate higher working speeds, automatic cycle operation, and for use with component loading and unloading devices for special and transfer line application.

These copying lathes, a typical example of which can be seen in our illustration below, are of interchangeable unit design, and by the use of standard unit assemblies they are built up for different capacities, fully or semi-automatic cycle control, and to comply



Two copying lathes arranged with automatic component transfer and loading equipment

with special requirements. As in all high-class machine tool construction, very close tolerances are observed at all stages of component manufacture and unit assembly to ensure complete interchangeability. Whenever possible, the makers try a machine out on samples of the class of component for which it is required. In this connection there is to be seen in the test department of the factory a number of interesting examples of components machined on the lathes, and machines designed for many forms of copy turning.

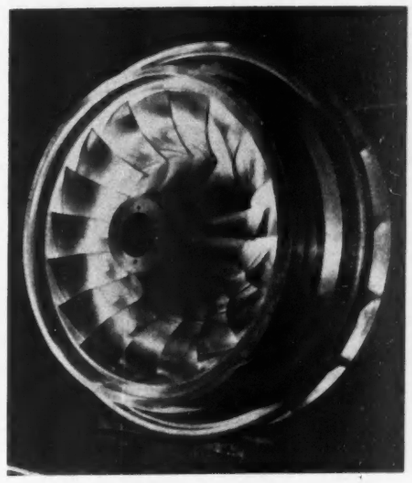
The lathes illustrated on the opposite page are of the most recent series, linked together and fitted with automatic component transfer and loading mechanisms for sequence operation. They handle components up to 26in long and 13in diameter and are fitted with a six-cut recycling device. This recycling device incorporates an interchangeable control drum by which individual cuts are preselected with trip dogs. The setting of these dogs determines the length of cut and the position and duration of half-feed and skip-feed forward. With this control it is possible to work with either normal or half-feed, or to bridge over the parts of a component not required to be machined. An automatic swivelling template holder makes it possible to use two templates during a machining cycle. These machines have magazine or bar feed loading.

Escher Wyss, Ltd., Zürich

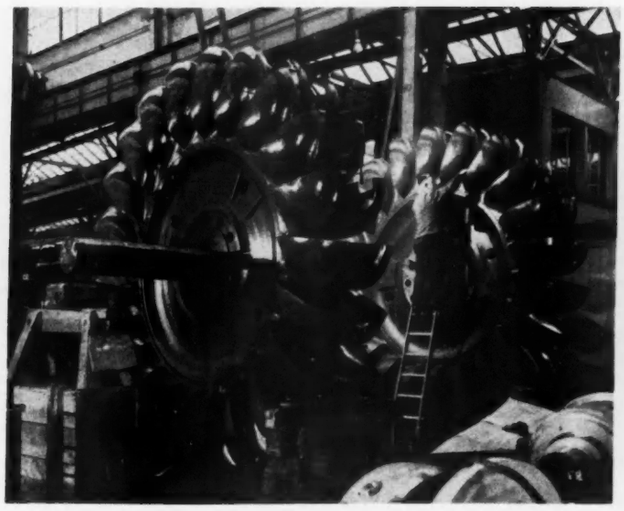
Hans Caspar Escher, the descendant of an old and influential Zürich family, founded in 1805, in partnership with Salomon Wyss and others, a mechanical spinning mill and workshop at the "Neumühle" near Zürich. Always interested in mechanical things, he had at the beginning of a commercial career changed over to architecture, but a visit to see an English spinning machine at St. Gallen made him decide to devote himself to industry. After obtaining information on spinning machines in France and England, he returned in 1803 to design his own machine which, though not perfect at first, in the favourable conditions prevailing at the time found a ready market. The mill however, soon outstripped the machine shop and by 1826 when H. C. Escher's son, Albert, took over this department, it employed only sixteen people. Albert Escher who had received his training in mechanical engineering in England, within a few years expanded the factory to several times its former size. By 1835, he had 400 people working under him and his turnover amounted to three times that of the spinning mill. His early death, ten years later, was a severe blow not only to his family but also to the firm. Caspar Escher's own death in 1859 ushered in a period of stagnation which lasted until Henry Zoelly, the designer of the Zoelly turbine, became technical manager in 1888. In its early days the firm had established a high reputation for its spinning machines and waterwheels. The manufacture of the latter, for which there was a great demand, brought in its train that of mill equipment, paper machines, and pumps. From the assembly of the engine parts imported from England for the first steamship on the lake of Zürich (1835) dates the production of complete ships and their engines which were soon to be seen on all the Swiss lakes and were exported as far as the Amazon. That development came to an end as the size of ships increased, but by the time this was beginning to make itself felt, the rise of water power for the generation of electricity provided compensation in another direction. For many years also the firm held a leading position in the manufacture of steam turbines through the Zoelly Syndicate formed in 1904.

At the present time, Escher Wyss, Ltd., comprises the Zürich works with 2600 employees, of whom as many as one-third are staff members on account of the large size of the design office. Subsidiary works exist in Germany at Ravensburg (founded in 1846) and Lindau (established 1916, sold later, and re-acquired in 1952), and Schio (Italy, 1920), also at Boksburg near Johannesburg (Escher Wyss Austral Ironworks, Ltd., 1949). The company also holds part of the share capital of Maschinenfabrik Andritz (Graz, Austria) and of Cleaver-Brooks (Milwaukee, Wisconsin). The German subsidiaries employ together about 2200 people, Schio has 500, the South African firm the same number, and Andritz about 1000. Research, and for the most part design, are done in Zürich.

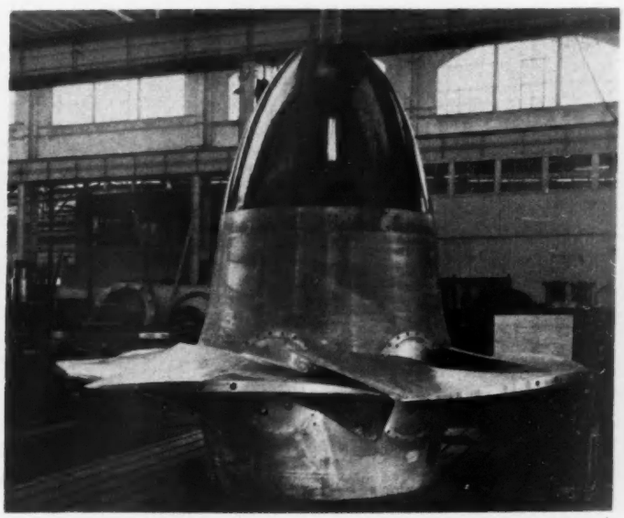
Construction of the factory at Hard where a new site of 160,000 square metres had been purchased, began in 1891. The foundry has been fully mechanised in recent years. An object of particular interest to be seen in the machine shop is a vertical boring mill of which the normal turning diameter of 9m can be increased to 16m by offsetting the columns supporting the cross rail or by placing one of the columns in the centre of the turntable and the other on the shop floor, as for instance when turning the inside of large spiral casings. Another ingenious arrangement comprises a large work and mounting floor plate along which three horizontal boring mills are able to travel on the same bed. This enables a number of large workpieces to be set up side by side and machined in turn, so as to



Runner for one of the high-head Francis turbines for Fionnay (Mauvoisin) power station (62,800 h.p. with a head of 455m). Three horizontal Francis turbines for a net head of 409m to 522m and an output of 65,350 h.p. to 98,100 h.p. are under construction for Ferrera power station



Pelton runners for Biasca power station, where each of four sets will develop 107,200 h.p. The runners will be mounted at the overhanging ends of the generator shaft

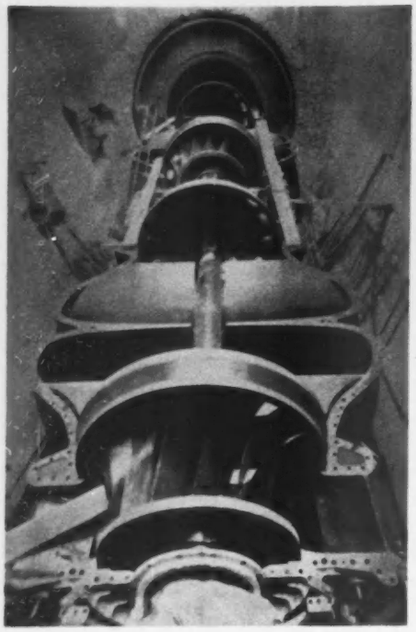


One of two Kaplan runners for Pirttikoski power station (Finland). Maximum output 91,300 h.p. each, at a head of 29m. Diameter of runner 5·8m

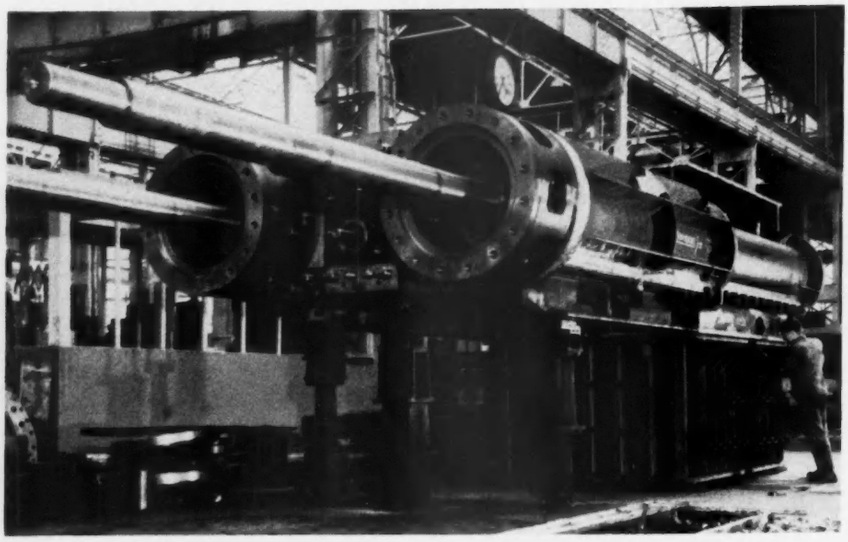
utilise the milling capacity as continuously as possible. For the milling of Kaplan blades, a large electronically controlled copy-milling machine is in use.

Some very large Francis turbines have been supplied, the largest being a number of 115,000 h.p. turbines for Manchuria; four turbines of 110,000 h.p. are at present under construction.

The design of Francis turbines for high heads is something of an Escher Wyss speciality. Thus, the company is building three turbines for Ferrera power station (Hinterrhein) in co-operation with Ateliers de Charmilles (an agreement to share research work has been concluded with that firm). The Ferrera turbines are to develop 100,000 h.p. each with a head of 522m.



This design of four Francis runners on the same shaft was built ca. 1910 in ten units for the Rhine power stations of Laufenberg and Augst. One of the Laufenberg runners, shown here, will be replaced this year by an almost identical design



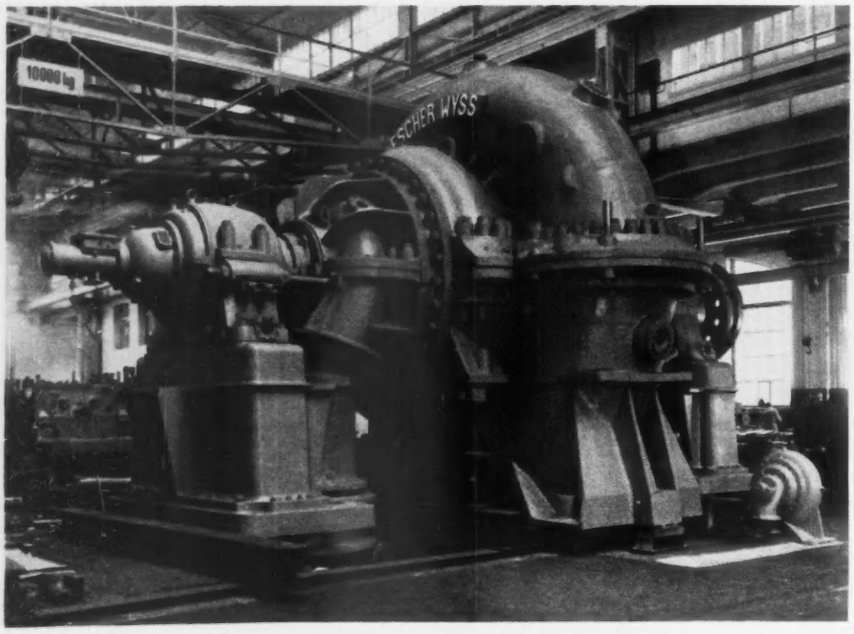
Bottom outlet gate of welded design, with 1·80m by 2·90m opening, for Mauvoisin dam. When opening the (normally vertical) gate, the two rods have to support a force of about 300 tonnes each. The box-shaped lower section is grouted in and forms the transition to the discharge gallery

On page 21 we show one of the 62,800 h.p. runners for Fionnay power station (Mauvoisin), which has the highest head used by Francis turbines at the present time (455m). The Pelton turbines for Biasca (bottom left, page 21), which are double turbines of 107,200 h.p. output, will be substantially surpassed by the three 125,000 h.p. turbines for Thierfehd (Linth-Limmern A.G.). These also are double turbines, with the Pelton wheels arranged on either side of the generator, and will use a head of 1036m.

A long succession of Kaplan turbines have been or are being supplied, including machines for Birsfelden (30,000 h.p., h=30m,) Donzère-Mondragon (65,000 h.p., h=26m), Assuan (also 65,000 h.p., h=30m), and Pirttikoski (Finland) for which the first of two 90,000 h.p. units is being completed (bottom right, page 21). For twenty years, Escher Wyss has been engaged on the manufacture of tubular turbines of which about seventy have been installed. Recent orders include four 6000 h.p. units for the first Moselle power station at Trier. The runners of these turbines, which will operate with a head of 7m, will be 4·6m in diameter. Some high-duty storage pumps have been supplied such as two of the Limberg pumps, of 85,000 h.p. and for a head of about 410m (left). Together with Sulzer Brothers, the company also supplied the pumps for the Lünersee storage scheme which absorb 55,000 h.p. and pump against a head 960m.

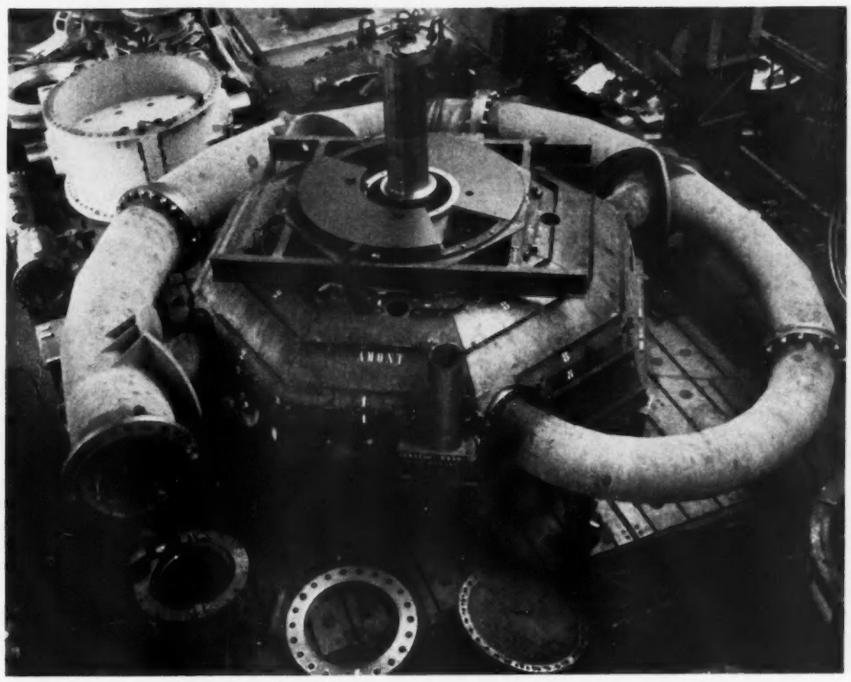
Steam turbines are being built in sizes up to 115MW, and for steam inlet conditions of 165 atmospheres and 600 deg. Cent., with reheat to 565 deg. Cent. Other turbo-machinery includes centrifugal and axial compressors and blowers for the chemical industry, mines and steel works. Gas turbines have been developed based on the closed cycle with heat exchanger suggested by Ackeret and Keller in 1935. The first industrial plant of this kind was a 12·5MW generating set for the St. Denis power station of EDF, installed in 1951. The use of a closed circuit enables high pressures to be employed with resulting high specific output (thus the 20,000 h.p. hign-pressure turbine rotor has a diameter of only 520mm). Clogging of the blades is avoided, and the output can be varied by altering the pressure inside the system. A recent plant based on these principles has been installed at Ravensburg.

Escher Wyss, Ltd., builds refrigeration plant and heat pump installations (and sometimes a combination of the two, as at Oberstdorf (1958), where an ice-rink and swimming bath are operated side by side). A particular aspect of the principle of the heat pump is the application to evaporators in the so-called thermo-compression process. In one sugar mill, a 6000kW plant, installed in 1945–46, evaporates 150 tons of water per hour. A substantial success was scored, when in 1952 it became possible to apply the method to sulphite waste liquor (by adding gypsum to prevent incrustation of the heating surfaces). The programme of thermo-compression and multi-effect evaporators is supplemented by the production of continuous push-type centrifuges.



Storage pump for Limberg power station (Tauernkraftwerke A.G., Austria). Maximum input 62,500kW. Delivery head 320m to 420m. In front on the right is the model pump

Ateliers de Charmilles S.A., Geneva



Shop assembly of one of four 88,000 h.p., four-jet, vertical-shaft Pelton turbines for Cubatao (Brazil), for a head of 684m. The injectors are fitted with straight-flow internal servo-motors ; the spiral as well as the housing are fabricated, and will be encased in the foundation concrete

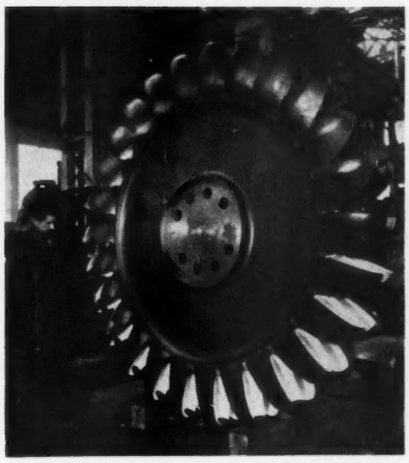
The Charmilles Engineering Works, Ltd. (Ateliers de Charmilles S.A.) employs some 1400 workers at its three factories in Geneva, viz. the main factory in the suburb of Charmilles, another in Châtelaine, and that of Motosacoche S.A., as well as a subsidiary, Moteurs Mag S.A. at Annemasse (France). The present company grew out of three constituent firms : Faesch and Piccard, later S.A. Piccard-Pictet, of which the co-founder was Paul Piccard, the designer of the Niagara turbines of 1891, and which later produced the famous " Pic-Pic " automobile ; the Ateliers H. Cuenod (founded in 1899) ; and a firm founded by the brothers Dufaux for the production of a petrol engine for bicycle propulsion, this firm becoming known as Motosacoche S.A. in 1905. Ateliers H. Cuenod, which subsequently became the Châtelaine Works, started the now very important manufacture of oil-burning equipment in 1920; Motosacoche in the 'thirties turned from motor-cycle manufacture to light industrial engines, superchargers, and precision engineering in general.

In passing we mention the recent development of spark-erosion machines (" Eleroda ") at the main factory which also makes brake control equipment for rolling stock and automatic speed governors both mechanical and electronic.

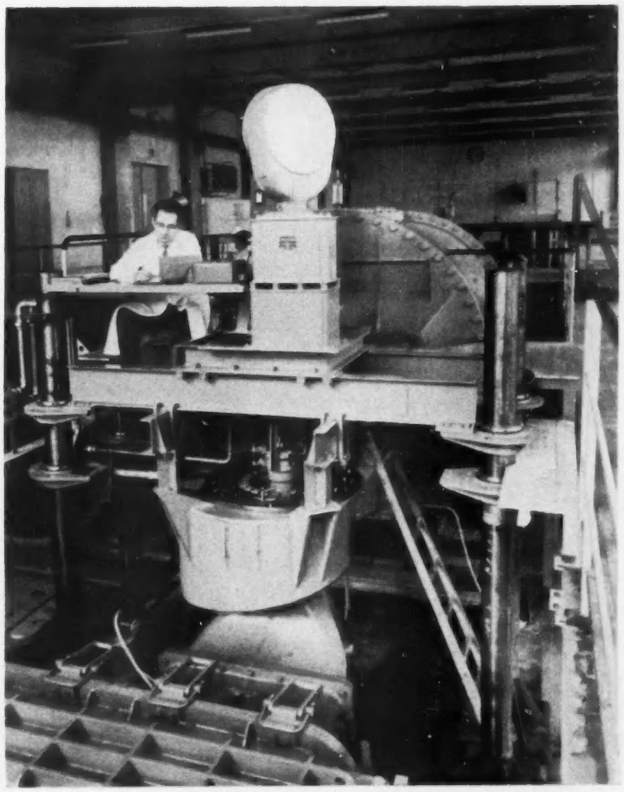
The international reputation of the group, which employs some 1400 people, is based on the achievements in its main field of activity, hydraulic engineering. The construction of water turbines is the task of the Charmilles Works from where many pioneer designs have originated. As in so many Swiss factories, one is struck by the great volume of work —involving in this case mostly large and very large items— which is handled on a comparatively modest floor space without giving the least impression of untidiness or congestion.

The works has attached to it an important fluid mechanics laboratory located in a new and large building which also houses the offices connected with experimental work. The building has a deep basement in which are located large reinforced concrete water tanks for supplying the hydraulic circuits, several motor-driven pumping sets supplying water at the pressures required, and air blowers and compressors for aerodynamic testing. The total motor power installed exceeds 1000 h.p. and the tanks have a combined volume of about 800 cubic metres.

The laboratory shown below comprises several test benches for the various kinds of water turbines, as well as an aerodynamic test bench which affords a convenient way of carrying out a large number of tests, in particular in preliminary work, since models may be constructed of wood or plastic material, and thus are lighter and can be more easily altered. On the left we show an 88,000 h.p. vertical Pelton turbine for a head of 684m, for the Brazilian power station of Cubatão. The spiral feeding the four injectors is of welded construction, and the injectors are of the straight flow internal servomotor design. Overleaf is the runner of a 37,000 h.p. horizontal Francis turbine for a 310m net head, for Bancairon Power Station (France). The double-sided runner is an integrally-cast open design, i.e. without outer band, which has been found greatly to reduce the erosion caused by sand in the water. Charmilles Engineering Works have supplied the turbines for the five highest heads in the world, including Chandoline (Dixence) of 1932 which developed 25,000 h.p. under a net head of 1750m. The buckets at that time were individually die-forged



31,000 h.p. Pelton runner for Reisseck power station (Carinthia), which has the highest head in the world (1765m). The runner is a single casting of 12 per cent chrome steel. A similar 25,000 h.p. runner, built in 1932 for Chandoline (Dixence) power station, for a head of 1750m, had individual die-forged buckets dovetailed into the disc



One of the two Kaplan test benches in the hydraulic laboratory of the Charmilles works. By adjusting the height of the platform on the supporting columns, the bench can be adapted quickly to various set-ups. In the construction of the models, glass-fibre-reinforced plastic is used extensively

Integrally cast double Francis runner of horizontal 37,000 h.p. turbine, for a head of 310m for Bancairon (France). The open design, without outer rim, has been found to reduce erosion from sand particles

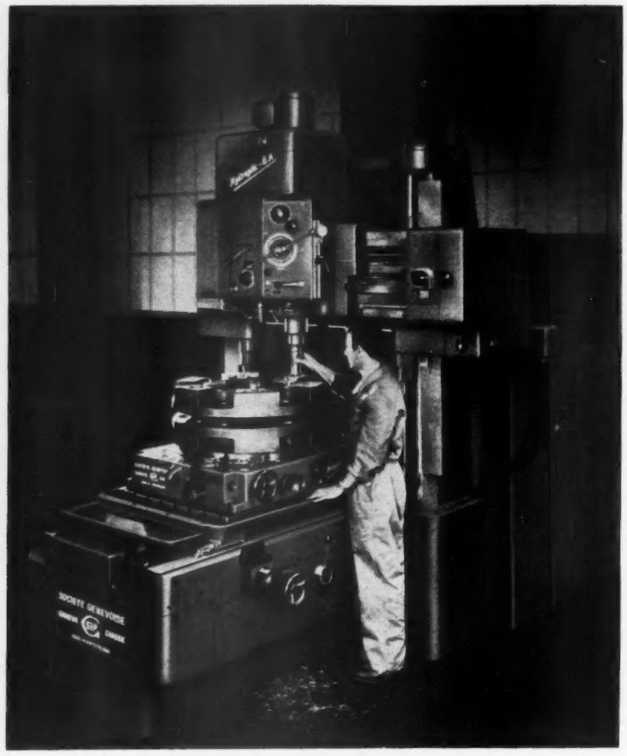
and dovetailed into the periphery of the disc. In the case of the 31,000 h.p. Reisseck turbines, operating under what is now the highest head in the world, viz. 1765m, the runners, one of which is shown on page 23, were cast in a single piece.

Société Genevoise d'Instruments de Physique

The firm of Société Genevoise d'Instruments de Physique, which was set up in 1862 by four physicists—De la Rive, Colladon, Boissier and Soret—has played an important part in the field of metrology, and its jig borers (right) and measuring machines are known throughout the world. The basic accuracy of the equipment made by this firm is dependent largely upon the accuracy of the standard scales, and in the dividing laboratory visitors will see how infinite trouble has been taken to ensure the maintenance of constant temperature and to prevent vibration. To facilitate temperature control this laboratory has been built underground and the working room temperature of 20 deg. Cent. is maintained to within 0·1 deg. Cent. To further ensure temperature stability the machines themselves are housed in special insulated cabinets, and vibration is virtually eliminated by mounting them on large concrete blocks of about 130 tons each and supported on springs.

Particular interest attaches to a photo-electric dividing machine developed by the firm ten years ago for making scales and illustrated below. This machine is of the copying type and on it the graduations are transferred from a master scale built into the machine on to a blank scale. A carriage supporting the master scale is moved on the guideways of the bed by a lead screw and nut as on earlier machines. The screw, however, serves only to displace the carriage and not to determine its position. The master scale moves under a photo-electric microscope. Parallel with the master, and on the same level, is mounted the blank scale which moves under the diamond point. Close to the master scale, but fixed on the bed, is a template with an index line. The lead screw advances the table to within a few microns of the final position at which it stops. An illuminating device, projecting a very narrow slit on to the master scale, is then automatically switched on. The surface of the master scale being specular, the light is reflected on to the microscope, where, passing through a grid it operates a photo-electric cell. The current thus produced, amplified and modified, actuates the fine setting motor which moves the table very slowly (about 1 micron per second). The width of the grid is reduced considerably, and, consequently, the voltage of the photo-cell-current is reduced to a minimum, thus stopping the fine setting motor. The diamond point then engraves a line on the blank scale.

The firm points out that this description is rather simplified. For example, the microscope does not view only one graduation line but fifty. The index template also carries fifty lines. The positions of the lines on the new scale, therefore, are computed electrically by averaging out the positional errors of a group of fifty on the built-in master scale. The accuracy of this dividing machine is more than 1μ.



"Hydroptic-6A" jig borer

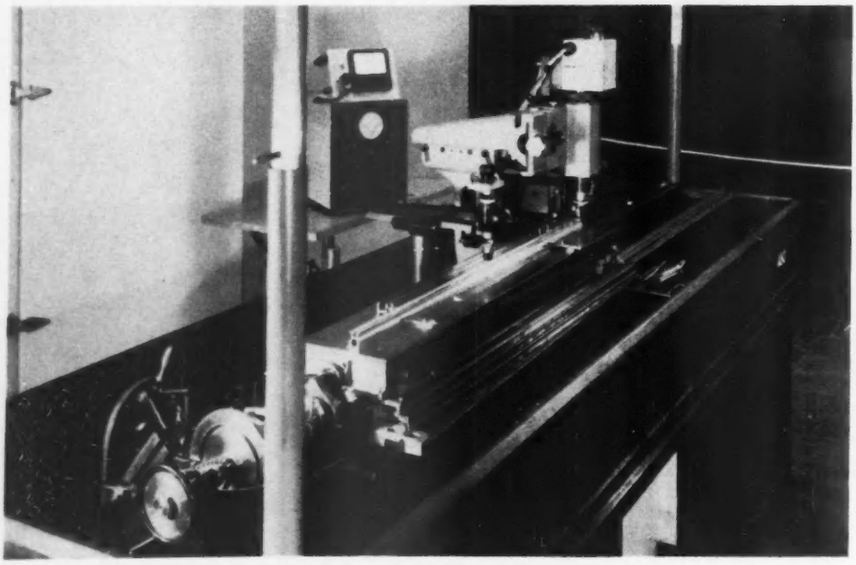


Photo-electric dividing machine for highly precise scales

Assembly Plant of General Motors Suisse S.A., Bienne

Between 1906 and 1920, Switzerland exported some 12,000 cars of a total value of over 225 million francs. In 1912, 35 per cent of cars registered in Switzerland were Swiss-made. Manufacture was orientated entirely towards high-class, small series production, and closed down completely under the competition from foreign mass production. During the crisis of the 1930s, quota restrictions on car imports were modified to favour firms which would assemble their cars in Switzerland.

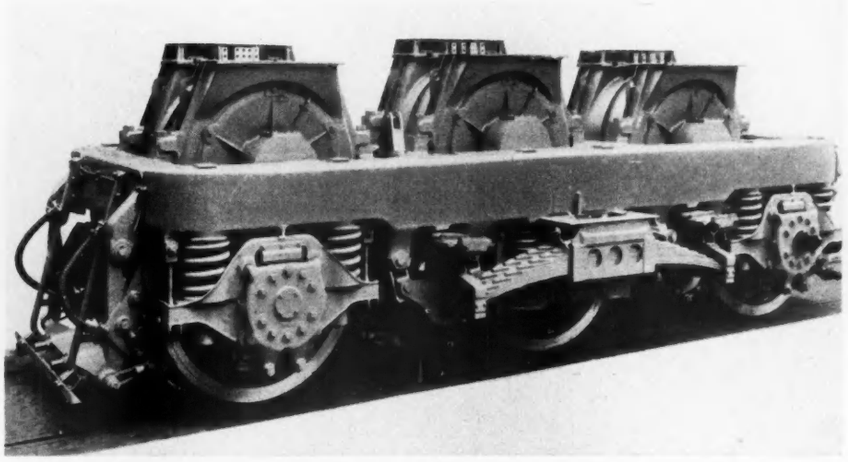
One of the towns particularly hard hit by the crisis was Bienne (Biel), which relied very largely on the watch industry, whose export trade had slumped very severely ; as a result, about one-third of the workers were unemployed. When, in 1934, General Motors became interested in establishing an assembly plant in Switzerland, the town council erected a factory and leased it to the company. In 1947, General Motors bought the plant, extending it from 14,000 square metres to 51,100 square metres in the years 1955–1957. In 1957, the 50,000th car left the factory.

Swiss Locomotive and Machine Works

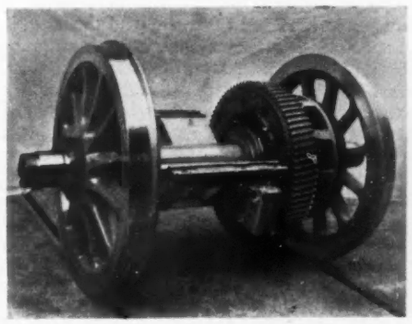
As the Swiss Locomotive and Machine Works, Winterthur (SLM), was founded in 1871 in the early days of the development of the Swiss railways, it is natural that its resources were mainly directed to the design and manufacture of locomotives. Towards the end of last century, the firm, which had up to then been mainly concerned with the manufacture of steam locomotives, took up the design of electric locomotives and later turned its attention to diesel traction. For some years now it has also specialised in the design and construction of high-speed, light-weight rail coaches and train units, as well as steam, diesel and electric locomotives and railcars for service in all parts of the world.

In 1886, the firm took up the manufacture of internal combustion engines, mainly gas engines, and since 1909 it has taken an active part in the general development of the diesel engine. It now makes diesel and gas engines from 15 to 3000 b.h.p. for stationary, marine and traction purposes; and its other products include rotary air and gas compressors, vacuum pumps and blowers, and oil-operated reverse and reduction gears for both traction and marine applications, as well as general engineering equipment.

During their tour of the works the visitors will have an opportunity to see, in course of construction amongst the many locomotives, the mechanical parts of the C_0–C_0, 6000 h.p. electric locomotives for the Swiss Federal Railways. A method of suspension which has been developed for these and other locomotives is well worth examining in the shops. The outer axles of each bogie on these locomotives are fitted with axleboxes of special design. In these outer axleboxes a laterally flexible bearing arrangement has been incorporated to minimise the guiding forces and mass effects as far as possible by damping the dynamic forces at the wheel flanges. One of the bogies is illustrated, and we also show the various component parts in their relative positions.

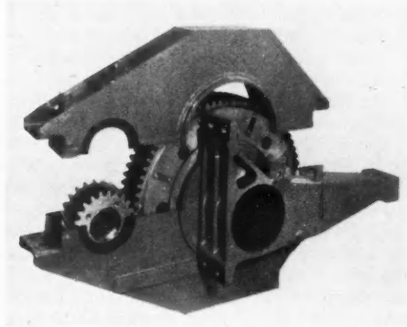


Driving bogie of 6000 h.p., C_0-C_0, a.c. locomotive of the Swiss Federal Railways

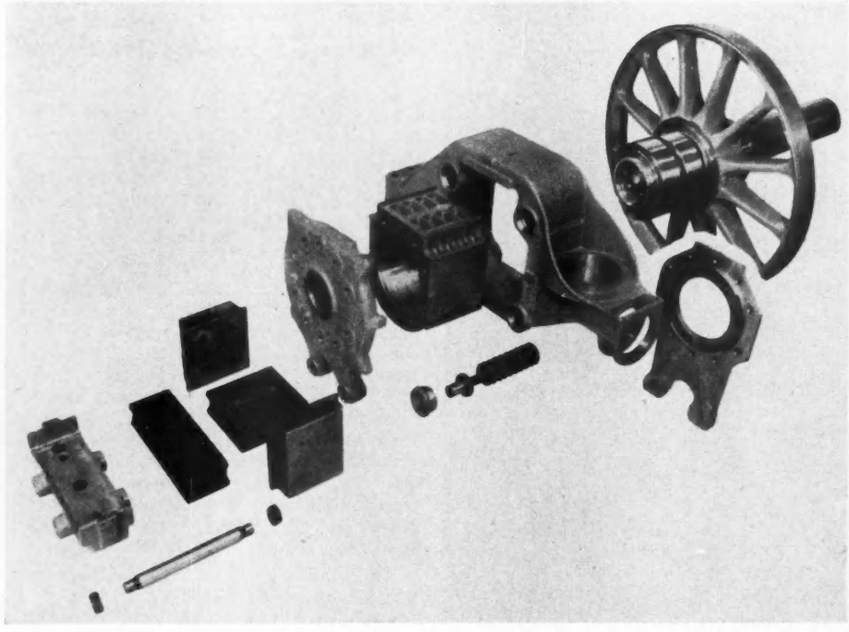


Driving axle with spring drive, showing gear wheel withdrawn from spider

Each axle bearing consists of an outer housing which surrounds a concentric inner housing; three rubber elements are bedded between these housings. A fourth rubber block, which, together with the upper element, supports the vertical axle load, is arranged between the lower edge of the outer housing and a carrying member supported from the downward-extending arms of the inner and outer bearing covers. The two bearing covers are securely bolted to the inner housing. Thus the upper and lower rubber elements function in parallel and are both subjected to compressive forces. The rubber blocks in front of and behind the axle transfer mainly the tractive forces. These blocks, which also impart a considerable degree of rigidity in the direction of the forces, are, in addition, pretensioned to correspond approximately to the tractive effort when starting. At right-angles to the longitudinal axis of the vehicle, the four rubber elements function under shearing stress and thereby offer a softer characteristic than in the other directions. In the case of lateral displacement of the axle they offer a definite restoring force which, however, is not sufficient to guide the wheel-set reliably. For this duty there is provided a centring arrangement which consists of four pretensioned helical springs built into the outer housing; these springs operate on lugs attached to the outer bearing cover, by way of push rods.



Flexible drive from stub shaft or traction motor side



Laterally flexible axleboxes of 6000 h.p., C_0-C_0 locomotives

This firm is also responsible for the construction of the mechanical parts of Brown Boveri mobile gas-turbine-driven electric power plants such as that we described in our issue of January 6, 1956, page 31. These plants are for the Comisión Federal de Electricidad, Mexico, and are, in effect, mobile power stations of 6200kW. They comprise two wagons—one carried on eight axles mounting

the gas turbine and generator and the second carried on four axles mounting the transformer, control room, battery set and an SLM diesel generator set for starting and heating. The service weight of the generating wagon and its equipment is 160 tons, and that of the control wagon 78 tons. One of these control wagons will probably be in the erection shop of SLM at the time of the visit.

A large number of SLM oil-operated transmission gears being supplied to British Railways will also be seen in course of construction in these works. This firm has also supplied the flexible axle, or so-called spring drives, for the 2500 h.p. B_0–B_0 locomotives for the Southern Region of British Railways. These drives are widely used on locomotives and their arrangement on a bogie can be seen in the accompanying illustrations.

The traction motors are rigidly mounted in the bogie frame, each being suspended on one side by two brackets on the centre transome and on the other side by two arms on the headstocks. One of these arms is above the driving axle, whereas the other one, designed as hollow stub shaft, surrounds the axle and carries the large gear wheel. A bracket on the arm used for fixing the gear casing incorporates an oil reservoir for the roller bearings of the gear wheel.

On the extended boss of the driving wheel centre, facing the axle drive, is pressed the torque transmitting spider. The eight arms of this spider engage in spring elements in the gear wheel, mounted concentrically to the driving axle. The pinion is mounted on the conical end of the traction motor shaft.

The eight spring elements of the gear wheel each consist of two concentric helical springs and two spring base plates. The torque corresponding to the tractive effort at 30 per cent adhesion can be transmitted, and in addition the full play of ±1in of the primary suspension is allowed.

Flexible drives of this type are being manufactured by the Swiss Locomotive and Machine Works for fifteen 3000 h.p. B_0–B_0 a.c. locomotives being built for British Railways by the English Electric Company, Ltd.

Maag Gear Wheel Company, Ltd.

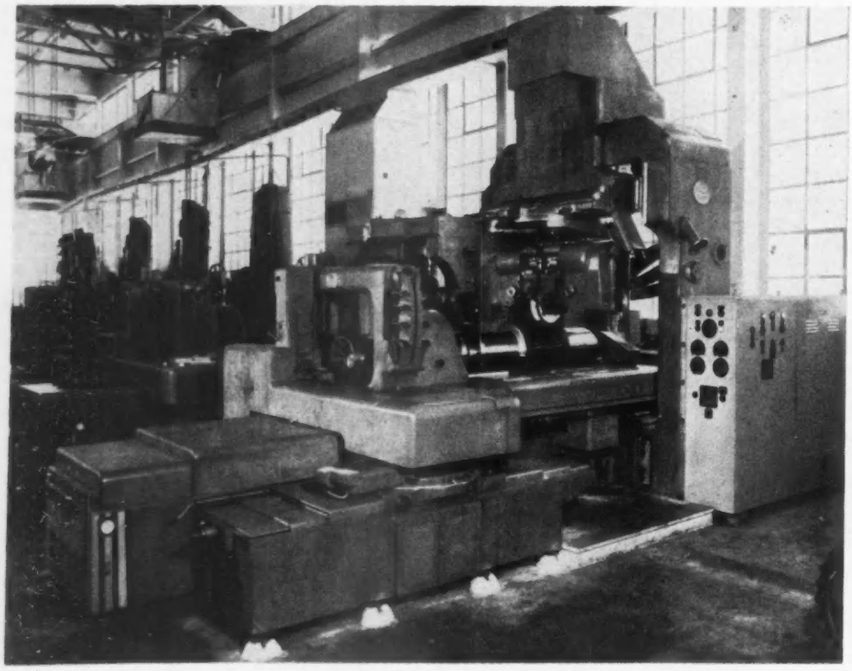
Production at the Maag Gear Wheel Company's works now falls broadly into two categories—all types and sizes of gears, racks and pinions, and gear cutting, grinding, measuring and testing machines. An excellent overall impression of the firm's latest machines and the principle upon which they operate can be obtained in the two main production shops for large gears, which we illustrate on this page. One shop is equipped for the cutting of large gears, racks and pinions to special order, and in the other, which is air-conditioned and temperature-controlled, the gears are ground.

Large gear cutting shop in Maag works

It should be recalled that, for the generating principle upon which the standard vertical Maag gear cutting machines operate, rack-form cutters are mounted in a reciprocating work slide. Generally. the tooth flanks are cut on the downward stroke, the cutter being withdrawn slightly from the work on the up-stroke. During return movement of the cutter slide the generating motion is imparted by a combined straight and rotary motion of the work table. As the cutter is of limited length, the generating motion is periodically interrupted to allow the gear blank on the table to return along the cutter into its initial position. During this return movement the work table does not revolve, but has imparted to it a straight motion only, therefore a dividing motion over one or several tooth spaces is carried out at the same time. This cycle is repeated until all teeth of the blank have been cut.

The firm's gear grinding machines also work on the generating principle and they use two saucer-shaped grinding wheels. During grinding the planes formed by the outer edges of the grinding wheels represent the flanks of an imaginary rack on which the gear to be ground rolls. This generating motion is imparted by a pitch block and steel bands, producing geometrically correct involutes corresponding to the base circle. Feed takes place in the direction of the axis of the gear to be ground, and during each feed stroke the grinding wheels gradually come into contact with the whole width of the tooth flanks. Feed is automatically stopped after one or two complete strokes covering the whole face width, and indexing takes place. As grinding of the tooth flanks takes place theoretically at one or two points according to the setting of the grinding wheels, only very little heat is produced and consequently no coolant is required, so that cracks and burnt spots on the ground tooth flanks are avoided.

An automatic device fitted on these gear grinding machines compensates for wear of the saucer-shaped wheels during grinding by moving the spindles axially. This adjustment is effected through two feeler levers



Part of grinding shop for large gears at Maag works

carrying flat faced diamonds which are moved to touch the grinding wheels every two seconds. If wear has taken place on the wheel edges the feeler levers close an electric circuit which actuates the compensating device until the grinding planes are restored to their initial position. The compensating motion is started immediately wheel wear amounts to 0·00004in, and each of the two wheels is separately compensated for wear.

On some machines there can be accurately ground corrected profiles which deviate from the true involute form on the tip and on the root of the tooth, the amount of correction being adjusted on the machine according to any calculated value. For this purpose the normal generating motion is automatically altered at the beginning and at the end of the profile by an adjustable correction device comprising a universal cam disc and a link motion. This device makes it possible to manufacture interchangeable gears with tip and root relief, and to reproduce them at any time with exactly the same profile.

Rack cutting machine for racks up to 49in long

The machine to be seen grinding the helical teeth on a pinion on the right foreground of our photograph of the grinding shop is the firm's more recently developed "HSS–90P" machine. This machine can be used for grinding spur and helical gears up to 36in outside diameter and with teeth up to 16·5in pitch circle diameter. It incorporates tip and root relief grinding mechanism, and the pitch block and band mechanism can clearly be seen on the left of the work table. Through an electrical control system a complete grinding programme can be set.

The rack cutting machine, which we also illustrate, is one of the largest made by the firm and is designed to cut racks up to 49in long with rack-form cutters, or 53in long with a single tooth cutter. At each machining cycle the work table is fed into the reciprocating cutter to the required depth, and then withdrawn and indexed along to the next station. The cutter slide stroke can be adjusted from 1·18in to 12·8in and has a cutting speed of 6 to 125 strokes per minute. The table in-feed for tooth depth can be varied to give from 9 to 240 strokes per tooth gap cut.

Swiss Industrial Company

The Swiss Industrial Company (S.I.G.) was founded in 1853 for the manufacture of railway goods wagons. The two other sides of its main activities, firearms and wrapping and packing machines, were introduced in 1860 and 1906 respectively, and to these original interests there have, of more recent years, been added the manufacture of electric battery vehicles, machine tools, hydraulic control equipment, pneumatic tools and pumps. The main sections of the works, situated on a 30-acre site at Neuhausen, now cover a productive floor area of some 750,000 square feet and provide employment for over 3000 people. Members of the Institution are to be shown the railway vehicle production shops and the assembly department for wrapping and packing machines. In the rolling stock shops there are under construction a variety of vehicles including some excellent examples of modern all-metal, lightweight, 2800 h.p., high-speed motor coaches for the Swiss Federal Railways.

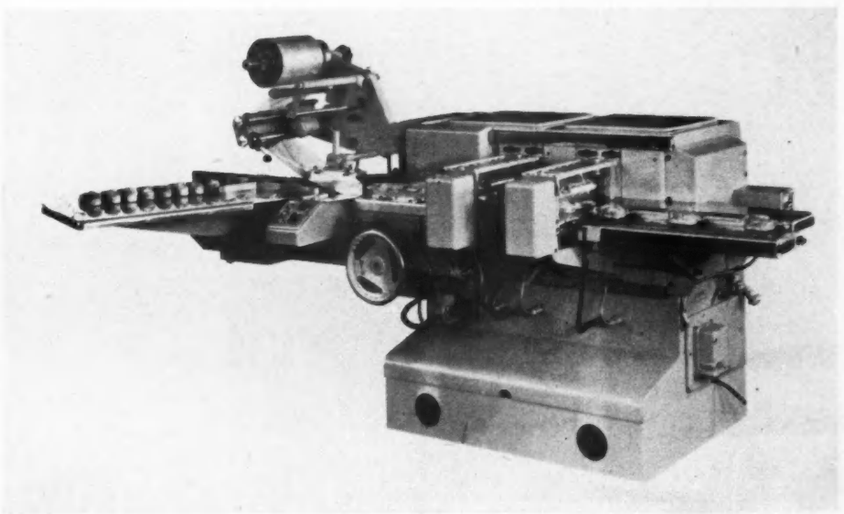
Amongst the packing machines under assembly is that illustrated below, which is a universal continuous packing machine for use in the food and allied industries. Its output is determined by the class of goods and nature and quality of the wrapping material, and on an average it completes 200 packets per minute. The articles to be wrapped are delivered by a pusher chain to the feed table of the machine, which may be set at any angle between 60 deg. and 90 deg. to the chain. The heat-sealing wrapping material is drawn off a roll and formed into a tube round the articles and two heater rollers weld its longitudinal seam. The individual pieces are spaced in the tube and the ends between each piece sealed by two heated rollers which are arranged transversely, the second roller also acting as a knife to separate the pieces. When handling wax paper, polythene- and pliofilm-backed foil, the second roller may also be used for cooling. The standard machine is adaptable for crimp folding the lateral ends, or other forms of fold sealing.

If desired, the machine may be fitted with a tear-tape device and a photo-electric register device can be incorporated for accurate location of panels of print on the packet. Changing over the machine to handle different pieces or shapes is effected by a few adjustments and only the folding box has to be changed.

A high-speed packaging machine for forming, filling and closing of bags now made by this firm has an output of up to 150 packets per minute. This machine is fitted with a photo-electric registering device and handles heat-sealing foil compounds or papers from rolls. The draw-off of the wrapping material via a forming head and shaping into a vee bag is done by two alternating heater jaws which seal the bag sides before it is cut from the web.

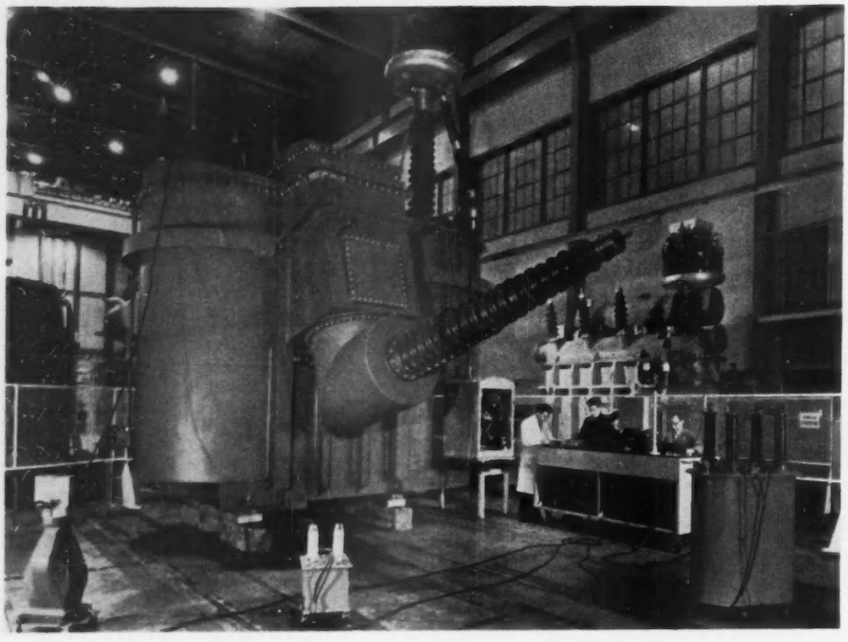
The formed bags are carried in two parallel rows by a twin conveyor through a bottom-sealing and embossing stations to the filling station and finally the upper edges are sealed together. The filling is done in various ways, depending on the product being handled, and, if required, volumetric devices can be fitted which enable two different ingredients to be put into the same bag.

The machine is completely enclosed with all of its driving components accommodated in the housing. The folding members are arranged in line and are entirely separated from the drive to facilitate supervision, maintenance and cleaning. An electromagnetic brake incorporated in the drive ensures the instant stopping of the machine in the event of an operation break, and, at the same time, the heater jaws are lifted off to avoid any risk of scorching the wrapping material.



Universal wrapping machine with an output of up to 200 packets per minute

Oerlikon Engineering Works



Testing a single-phase, 47MVA transformer in the new high-voltage laboratory

The Oerlikon Engineering Company (Maschinenfabrik Oerlikon, MFO), founded in 1876 by Peter Emil Huber, began electrical manufacture in 1884, and seven years later built the famous Lauffen-Frankfurt transmission jointly with AEG. This supplied 220kW over a 175km long, 30kV, three-phase line. The same year saw a 700V d.c. narrow-gauge locomotive. Generators, power transmission, and electric traction became the main fields of activity and nowadays account for 90 per cent of the turnover ; to this must be added the production, since 1900, of steam turbines, and, more recently, of centrifugal blowers. The number of employees amounts to about 4500.

Transformer Factory

Last year, a new transformer factory was completed,‡ which adjoins the main plant and comprises an erecting shop 24m wide by 54m long, continuing into a test area 24m wide by 18m long and an 18m by 30m high-voltage laboratory (shown above), with adjoining machine hall. The erecting bay, which will later be extended to twice its present length, is adjoined by a 6m wide section for offices, stores and ancillary plant. While testing and laboratory installations are considered adequate for several years at least, provision has been made for an eventual fivefold increase of the manufacturing space.

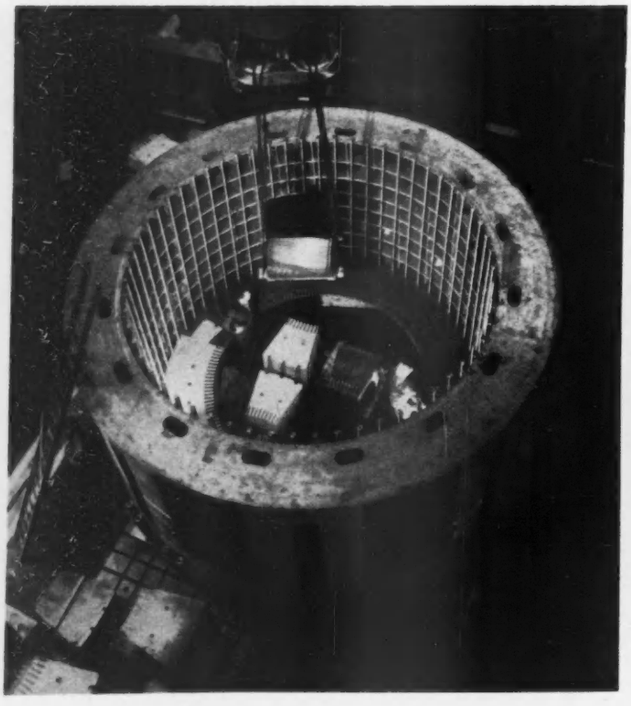
The building is a steel structure on piled foundations, 19m high over the main bay and 22m over the high-voltage laboratory, and is equipped with one 120-ton travelling crane (a second one to be added later), and two 2-ton, 10m radius wall-mounted cranes.

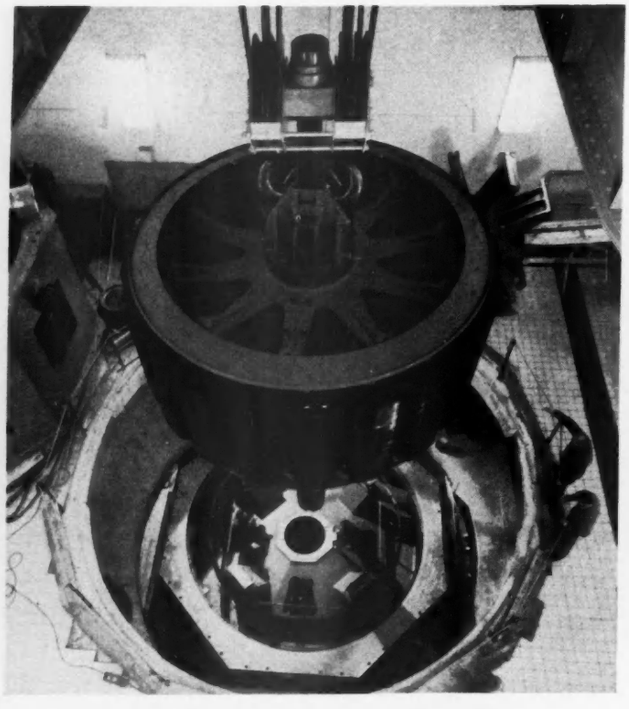
Between the testing and workshop areas the hall is traversed by a rail track, and is also longitudinally divided into a main erection area on one side, and the sub-assembly, drying and impregnating sections on the other. Since testing has to be carried out repeatedly at different stages of construction, this layout was adopted as it facilitates transfer to and from the test bay and high-voltage area.

For drying out, there are available several ovens as well as two vacuum tanks which can be heated to about 130 deg. Cent., one of 5m diameter, the other measuring 11m by 4·1m and 5·2m deep. This section includes blowers of up to 50,000 cubic metres per hour and vacuum pumps of 4500 cubic metres per hour and 7000 cubic metres per hour capacity for pressures down to 0·02mm Hg. The oil-preparation plant is equipped with vacuum filters, a degassing column for 600–1500 l/h at 0·02mm Hg, and a number of storage tanks ; later, semi-automatic operation is envisaged. In the final drying out process, the moisture content in the vacuum tank is brought down to less than 0·1 per cent. The transformer is then filled under vacuum with filtered and degassed hot oil.

Generating plant in the machine hall falls into three main categories, for high, medium and low-power tests. For power tests requiring 3·4MVA and over, there is a 42·5MVA, 50 c/s, 16kV, turbo-generator, which can be connected by a disengaging coupling to a 3·7MVA, 50 c/s, 6kV turbo-generator, the latter acting either as driving motor or as

‡ See also The Engineer, July 25, 1958, page 149





(Left) Stator of one of the 50MVA single-phase, 16⅔ c/s generators for the Göschenen power station of SBB. These are the largest single-phase units to date. (Right) Site assembly of first of two 40MVA generators at Handeck II power station of the Oberhasli Power Company

variable-frequency generator. Permanently coupled to this machine is a 600kW d.c. generator which serves as starting motor, exciter or generator for tests. The whole assembly can be run at 1000–3600 r.p.m., equivalent to $16\frac{2}{3}$ to 60 c/s.

For medium power (1 to 3·4MVA), the 3·7MVA machine can be used, if available. There is also a group of three machines : a 6kV a.c. generator, 6kV synchronous motor and a d.c. generator, laid out for 2·8MVA, 2·7MVA and 2·8MW respectively at 375 r.p.m. This set may be run synchronously at 50 c/s or driven by the d.c. machine to give $16\frac{2}{3}$ to 60 c/s. For power requirements under 1MVA, it is planned to have two groups which could be coupled together, each comprising one 1MVA, 3kV, three-phase, and one 600kW d.c. machine.

In addition, there is a group consisting of two a.c. machines driven by a 600kW d.c. motor, to supply medium frequencies up to 400 c/s and rated at 1040kVA, 3kV each. Lastly, a group of four machines comprises a 480 h.p. synchronous motor, two 200kVA, 1kV, three-phase generator/motors, and a 500kW d.c. generator. All installations and Ward-Leonard circuits are remote controlled. The whole driving machinery, at present totalling 8MVA, is supplied by a 4MVA, 11/6kV mains transformer.

Since the 42·5MVA, three-phase generator supplies high power, i.e. 16kV, 5300A, continuously, and impulses of up to 120kA, it feeds into a special busbar system which can be enlarged to 4×1000 square millimetres aluminium per conductor. Except for an air-blast circuit breaker, no switches are provided. Inside the laboratory the busbars run in a sub-floor channel. The remaining generators feed into two further busbar systems which are laid out for 10kV, 14MVA a.c., or 600V, 2500kW d.c. Each system has four busbars of 10×100 square millimetres aluminium. Of the twenty-two connecting cubicles, half are on one side of the testing bay, and half on the other.

All machines and installations are interconnected by a 480 square millimetre copper earth conductor with 120kA transient and 11kA continuous rating, and joined to the floor reinforcement which is in two layers of 15cm to 30cm mesh welded at the crossing points. Nine distributed tubular earth points give an earth resistance of less than 0·3 ohms. The water cooling system consists of 200mm diameter inlet and 240mm diameter return pipes placed in sub-floor channels ; it is laid out for 33 litres of water per second.

In the high-voltage laboratory voltages of 1MV, $16\frac{2}{3}$ to 400 c/s can be generated by a triple transformer cascade rated at 1·2 MVA at 1MV. A Haefely impulse generator for 3·2MV and 160kWs is installed which can later be increased to over 4MV and 400kW. This generator has at present sixteen stages of 0·5 μF each which can be charged to 200kV by oil-filled selenium rectifiers to give two discharges per minute. Ancillary equipment includes a capacitative and a 15kΩ, 400 pF Haefely-Berger voltage divider, a 500Ω ohmic divider, several cathode-ray oscillographs, and a slewing spark gap equipped with 2m diameter spheres. With a view to noise measurements on transformers, sound insulation has been provided to limit extraneous noise to 60 phons, and a large sliding door will be fitted later between the laboratory and the testing area in the main bay.

Tests on a smaller scale can be done in a separate insulation testing laboratory which is equipped with a preparation plant, an impulse generator of 600kV and 1·6kW, and a 180kV, 50kVA, 50 c/s transformer. In an adjoining room there is an electrolytic tank for plotting field distributions.

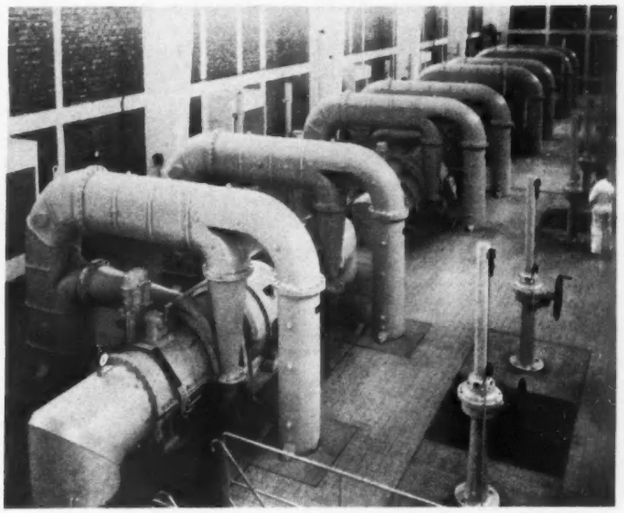
Extensions are planned to the machine hall and generating plant and will include three single-phase 15MVA transformers for temperature rise tests.

The new transformer factory is designed for the construction of three-phase transformers of 250MVA, and single-phase units of 200MVA, as well as groups of up to 600MVA.

Products

We concentrate on some of the more recent developments amongst the company's products. Oil-quenching circuit breakers have been a main line of manufacture for many years. The amount of the oil filling has been reduced drastically in the course of the years by introducing the counterflow quenching chamber, or for currents over 15kA, a combination of axial and cross flow. Sizes up to 150kV and 5000MVA are being made and still larger ones are being developed. A testing laboratory giving a short circuit power of up to 2 by 1500MVA is available.

Details were released in 1954 of the "Orlitsa" insulation for generator windings, consisting of soft mica foil bonded by epoxy resins. An improved version is stated to be stable at 155 deg. Cent. The strength of this insulation is such that it resists stresses due to differential expansion between the core and the windings which destroy shellac bonded mica.

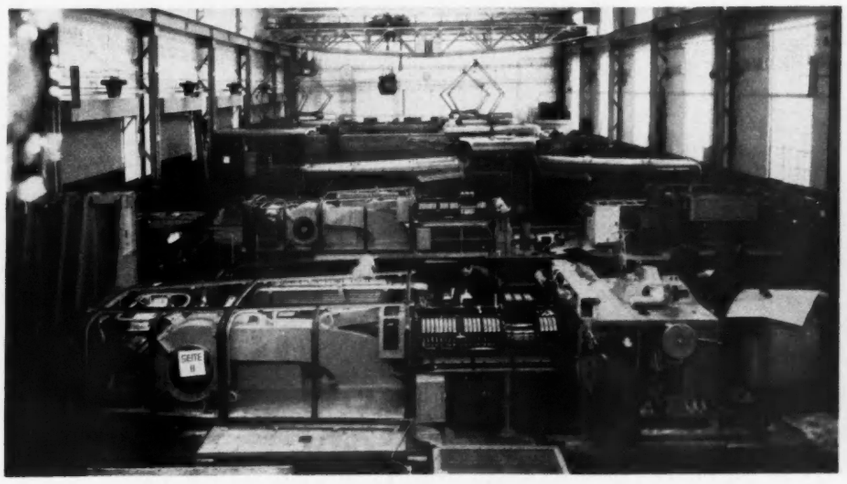


Blower installation of Mol research reactor. Four twin sets of radial blowers, each driven by a 950kW, 3kV, 2970 r.p.m. induction motor, exhaust 140 cubic metres per second cooling air from the graphite-moderated reactor

MFO has played a leading role in railway electrification of many countries. This goes back to the early years of the century and the beginnings of main line electrification in Switzerland, Sweden, Norway, Germany, Austria, and elsewhere. After the last war came the evolution of industrial current traction, and more recently of dual frequency traction.

It was the success of the "CC-20001" (104 tons, 65 km/h, 4300 h.p. hourly rating) on the 50 c/s, 25kV lines in Savoy which prompted the SNCF to adopt industrial current for its major electrification schemes in northern and north-eastern France. For goods trains of up to 2400 tons on the Valenciennes–Thionville line, the 4150 h.p., 3-phase, frequency-changing C_0-C_0 locomotives were equipped with squirrel-cage three-phase motors. The latest designs are the 2900 h.p., 120 km/h "BB-13000," and the dual frequency locomotive "BB-30000" 5000 h.p., 160 km/h, which are both being fitted with single-phase 50 c/s motors. The introduction of universal traction on the trans-European expresses, due in service in the summer of 1961, will enable these trains to run on 3000V and 1500V d.c., as well as $16\frac{2}{3}$ and 50 c/s a.c., without change of locomotive.

In the field of turbo-machinery steam turbines of up to 60MW and radial blowers are being built. The illustration above shows a typical blower installation. The blowers are equipped with four individual diffusers in place of diffuser blading ; the largest to date has been a 150,000 cubic metres per hour, 8050kW, two-stage machine. A lightweight continuous pumping unit for mercury arc rectifiers has been developed.



View of locomotive erecting shop

Adolph Saurer Ltd.

Few works can be situated in more pleasant surroundings than that of Adolph Saurer at Arbon, on the shores of Lake Constance. This firm was founded by Franz Saurer, who, in 1853, opened a small ironfoundry in St. Georgen for the manufacture of cast components for textile machines. Some ten years later the concern was moved to its present site at Arbon, where a machine shop was added. With the active support of the founder's sons the business prospered, and in 1869 the production of the first hand embroidery machine instituted a succession of developments in textile machinery, which to-day includes ribbon and weaving looms exported to all parts of the world.

The progressive nature of the firm was such that it is not surprising that in 1888 a kerosene engine was designed and built, and this was followed by petrol engines for vehicles. The first "diesel" engine was developed in collaboration with Dr. Rudolf Diesel in 1908, and since that date the firm has steadily progressed with the development of the oil engine. Its production shops now cover an area of some 100,000 square feet and provide employment for 4000 hands in the manufacture of textile machines, engines and vehicles. Visitors to the works will note with interest the way in which the manufacture of diesel engine and textile components is carried on side by side in many parts of the main machine shops, although certain special units such as injectors, pumps and superchargers are made in special departments, and the main unit and final assembly shops are quite separate.

One of the most recent developments of the firm is a new series of engines for rail traction work. These engines, with a bore of 175mm and a stroke of 200mm and a high degree of interchangeability between parts, are being made in six-cylinder vertical, twelve-cylinder vee, six-cylinder flat, and twin-bank twelve-cylinder flat forms. Each model is available in different forms with natural aspiration or pressure-charged, or pressure-charged with intercooling, and the complete range covers capacities from 315 to 960 b.h.p. on U.I.C. continuous rating.

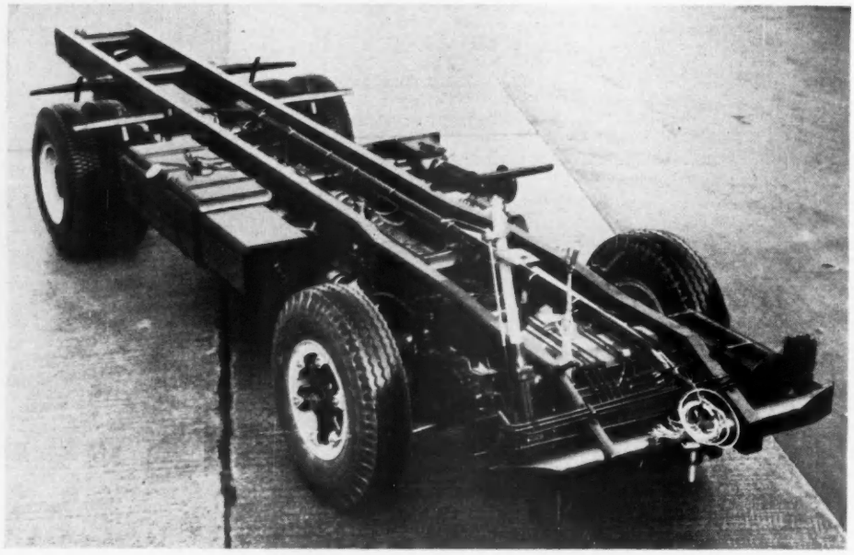
The visitors will see examples of the different forms of these engines under construction. We illustrate one of the firm's flat twin-bank, pressure-charged engines.

Those familiar with Saurer engines will see that the new engines incorporate the main constructional features of the firm's earlier designs in that they have an integral crankcase-cylinder block and direct injection into a dual turbulence combustion chamber in the piston crown. A further point is the retention of a crankshaft built up from separate units and incorporating large diameter main roller bearings which are fitted between the webs. These crankshafts are fine examples of precision assembly and are well worth inspection, as indeed are all the component parts of the engines.

The crankcase on these engines is not split but is brought in one piece all the way down and right round the bottom. The one-piece crankcase permits, without reduction in structural strength, the provision of large inspection doors to give full access to the crankshaft and bearing centre line and the camshaft.

The cast iron cylinder heads have special alloy seats for the valve heads. One of the inlet valves is masked to give some initial swirl to the air before it is drawn into the toroidal combustion chamber in the piston crown. The valves are operated from a gear-driven camshaft and the overlap of inlet and exhaust valves is only 19 deg., so that scavenging action is not very large. The wet liners are supported at the top and, to give a uniform water circulation over the entire length of the cylinders, the liners are surrounded by thin corrosion-resisting steel sleeves with water entrance openings at their lower ends. The water is forced to circulate past these openings, then rises along the liner surface and past the slotted outside circumference of the upper liner flange to the cylinder head. This arrangement gives maximum cooling action especially on the upper and thermally most exposed portion of the liner.

Forged aluminium-silicon alloy pistons with three pressure rings and two scrapers have cooling ribs on the underside below the combustion chamber. The crankshaft is built up of six main and two end pieces bolted together through the webs, to which balance weights are secured. The front end of the shaft is fitted with a " Holset " vibration damper and a gear drive for the water pump.

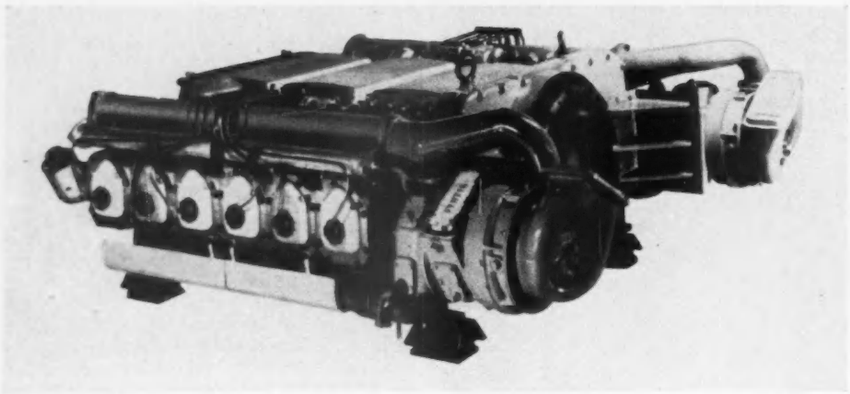


Chassis for passenger or goods vehicle of 9 tonnes payload

A gear pump in the sump delivers lubricating oil through a filter to the main rail and through a pressure-reduction valve to the camshaft bearings and valve gear. An electrically-driven priming pump builds up lubricating-oil pressure in the system before the engine starts. The fuel injection pump driven from the gear wheel train at the back of the engine is a monobloc Bosch unit delivering to centrally-disposed multi-hole injectors, one in each cylinder head. As already mentioned, the engines can be arranged for intercooling.

A majority of the diesel engines made in the factory are fitted to the road vehicles built in large numbers by the firm for all classes of transport. These engines cover a power range from 55 h.p. to 200 h.p. and more recently there has been introduced a four-cylinder air-cooled engine developing 56 b.h.p. at 2200 r.p.m.

Practically all forms of military, postal, passenger, goods and other vehicles made at this works will be seen in course of construction. A typical chassis for passenger or goods vehicles is shown above. This chassis is intended for vehicles having payloads up to 9 tonnes and capable of speeds of 86 k.p.h. A flat, six-cylinder, underfloor engine fitted in this chassis develops 160 b.h.p. at 2000 r.p.m. and drive is transmitted through an eight-speed gearbox. Gear changing is effected by compressed air and the required ratio is selected by the driver by movement of a small lever which actuates solenoid-operated relay valves in the box mechanism.



Flat twin-bank twelve-cylinder engine for railcar

Omega, Louis Brandt et Frère S.A.

It is recognised that in its watch-making industry Switzerland holds the position of leadership in the world, and no official meeting in that country by a body such as the Institution of Mechanical Engineers would be complete unless it included a visit to watch-making factories. It is to be regretted that only a limited number of members will be able to visit the works of Omega, Louis Brandt et Frère S.A., at Bienne, and those of the Roamer Watch Company at Solothurn, for all aspects of the craft are of considerable interest—from the initial production of minute parts to the finest possible limits in the machine shops, to the high degree of manual skill and dexterity in the assembly departments.

The Omega organisation was founded over a century ago by Louis Brandt in a small watch-making shop at La Chaux-de-Fonds. Louis Brandt not only made watches but he was active in developing new markets in other countries ; his work was carried on by his sons and, later, by his grandsons and great-grandsons, who are still participating in the business which now has interests in practically every country in the world. The company now makes watches in Bienne and Geneva, and the site of the factory in Bienne, which will be visited, was acquired about seventy-five years ago. Since that time, under a programme of development and expansion, some very fine new buildings have been constructed and equipped to meet the special requirements of high quality watch manufacture. At present some 2300 people are employed in the factories and offices, and production is of the order of 2500 watches a day. In the various departments, particularly those concerned with assembly, the standards of cleanliness and order observed can only be compared with those maintained in a hospital, and they provide a striking contrast to the conditions in engineering shops, familiar to members of the " Mechanicals."

An essential factor in watch-making is the maintenance of strict control over basic materials used in manufacture of the parts, to ensure that they conform to the required high standards of accuracy and quality, before they are released to the component production departments. For this purpose well equipped physical, metallurgical and chemical laboratories are fully engaged in inspecting all incoming materials. Special inspection departments are also fully engaged in testing for size, quality and finish all components such as cases, jewels, springs, &c., which are supplied to the factory from outside sources.

The accurate nature of the work entailed in manufacture in this factory will be appreciated when it is pointed out that in some cases tolerances of no less than 0·002mm—or about 0·00008in—have to be maintained in production. In one section of the machine shop, which we illustrate, there are about 130 automatics working under the supervision of fourteen setters, and the actual parts being produced are generally barely visible to the naked eye. To instance one relatively large part—a balance wheel spindle being made on a 70-second cycle is only 2·67mm long whilst it is 1·10mm on its largest and 0·063mm on its smallest diameter. The fact that sufficient parts for many weeks production can be stored in a small bottle will be cause for envy on the part of many visitors, particularly those concerned with the problems of manufacture and storing of large and heavy components in the engineering industry.

Amongst the many interesting machines to be seen are those used for the drilling of the plates for watches. On these machines an indexing work table has nests for twenty plates ; as a plate is indexed from station to station on this machine it passes through drilling, reaming and tapping stations. The operations are completed on a fully automatic cycle, one operator only being engaged in loading and unloading the components. Gear wheels blanks are punched and, with the pinions, are cut in a special department. The wheels are cut in packs, mounted on a mandrel, and the pinions on automatic magazine-fed machines. Many of the press tools used for blanking gears and other parts of watch movements have tungsten carbide dies which are cut by spark erosion methods. An interesting machine using a pantograph reduction system with the grinding wheel guided from a profile gauge has been developed for punch production. The operator of the machine cannot see the part during the actual grinding operation and an " audible " system has been developed for

Automatic section of production machine shops for Omega watches

(Left) Ultrasonic cleaning machines for watch parts. (Right) Watch movement assembly lines

his guidance. A microphone is placed near the grinding wheel and as the wheel contacts the workpiece the operator hears the sound of cutting through an amplifier. If the cut exceeds a certain rate the operator is warned by the high pitch of the noise and reduces the depth of in-feed accordingly. When the required metal removal is completed the operator can hear when the wheel has finished " sparking-out."

The most recent addition to the factory is a large battery of ultrasonic cleaning machines for the plates of the watch movements, as shown in one of our illustrations. After they have been cleaned a protective coating of " Epilam " is applied to the parts before despatch to the assembly lines. The " Epilam " coating prevents oil spreading on the plates when it is applied on the jewels during movement assembly; lubricant is thereby always concentrated on the spindle bearings and cannot disperse over the surrounding plate.

One of the many movement assembly departments can be seen in another illustration. The benches are generally set along the length of the glazed side walls of the building to take advantage of excellent natural lighting. At each working position along the benches are inset specially designed wooden arms rests, which conform in shape to the natural position of an assembler's forearms so that he is in a comfortable position with his arms supported, whilst at the same time his wrists and hands are steadied, but free to carry out the intricate assembly work.

Under the system of progressive assembly laid down, each operator is responsible for inserting one component or unit into a movement. The assembly work is done in small groups consisting of three or four assemblers and an inspector. When each movement is completed, up to the place where the balance has to be inserted, it is put in a plastics case so that it can be handled with ease in subsequent operations.

An equipment of particular interest in the assembly department is an electronic machine which has been developed for automatically completing the hitherto highly skilled operation of determining the length of the hairspring in the balance assembly. The operator of this machine simply places the balance assembly on a bearing and draws the free end of the hairspring between two spring-loaded rollers which grip it. A jet of air then starts the balance wheel oscillating and the end of the hairspring is steadily drawn through the rollers until the point of balance is reached. This stage is indicated by a pointer coming to rest and the operator moves a small lever mechanism which shears off the surplus length of hairspring. Two balancing stations are provided on the machine so that whilst one assembly is in process of being balanced, that on the other station can be removed and replaced by another unit.

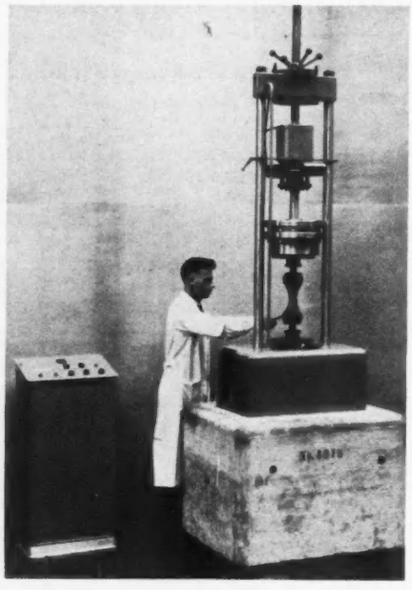
Finally each movement is regulated with reference to an electronic timer while mounted in a swivelling carrier through which it can be set at various angles to ensure consistent time-keeping properties in different positions. After further time-keeping checks over set periods the movements are again inspected before they are inserted in their cases. All waterproof watch cases are tested, usually six at a time, in a glass chamber in which they are subjected to a water pressure of 60 lb per square inch.

In a factory such as this the interesting machines and processes are far too numerous to list, least of all to describe in detail in an article where space is necessarily restricted. But we hope that the few points we have briefly dealt with will give an impression of some of the many interesting pieces of equipment and processes which can be seen in the watch-making factory of Omega, which is claimed to be the most modern in the world.

Alfred J. Amsler and Co.

The firm of Alfred J. Amsler and Co. was established at Schaffhausen in 1854, by Professor A. J. Amsler for the manufacture of his polar planimeters. Later he introduced modifications to these instruments whereby they became " integrators " and not only enabled the determination of the area, but also its first and second moments. As the firm developed, its productive scope was widened to include the testing machines for metals and constructional materials for which it is now so well known throughout the world. An interesting selection of the firm's standard machines, together with many machines for special applications, will be seen under construction and in various stages of assembly in the shops.

Amongst the noteworthy standard machines being made are the Amsler high-frequency " Vibrophore " fatigue testing machines. These machines can be used for testing both simple specimens and small complicated assemblies. They are available with a range of accessories for carrying out standard tests such as tension, compression, alternate tension/compression, shear and torsion. Two sizes of the machine are made, one of 2 tons and one of 10 tons maximum capacity, and the larger machine is shown in the photograph we reproduce herewith. The larger machine has a range of



10 tons capacity " Vibrophore " fatigue testing machine

frequency of stress cycles of 100 to 300 per second, and the smaller machine 50 to 200 per second.

The resonance principle on which the machines operate permits the use of frequencies up to 300 and their design is such that loads are accurately maintained to within 1 per cent both in magnitude and duration. The operating principle also makes it possible to determine the damping characteristics of a material under actual working conditions, and to determine dynamically the modulus of elasticity.

Also under construction in the shops at present is a large tension and compression testing machine for a French institute. This machine, with a capacity of 750 tons, takes specimens up to 65ft long. It has a space between the columns of 4ft, a ram stroke of 5ft and four measuring ranges with maxima of 750 tons, 400 tons, 200 tons and 100 tons. The gripping heads take steel ropes with socketed ends up to 4in diameter, round bars up to 5in diameter, and rectangular bars up to 13in by 6½in. The compression platens are 2ft square and are supported on spherical seats. The machine will have an overall length of about 110ft. It is arranged horizontally.

A special arrangement of universal testing machines has been developed by Amsler's for comparative tests on materials which have been subjected to nuclear radiation. This equipment comprises two 2000 lb capacity machines coupled to a single recording unit. One machine, screened within a transparent " glove-box " enclosure, is used for testing the irradiated material and the other for comparative tests on untreated material. The machines are hydraulically operated and the loadings are transmitted by a hydraulic line to an enclosed spring dynamometer having three load ranges of 2000 lb, 1000 lb and 200 lb.

Other Visits

Other visits of engineering interest in the programme which has been arranged include the works of Oerlikon Machine Tool Works Bührle & Co., Zürich ; Micafil, Ltd., Zürich ; and Contraves, Ltd., Zürich. The range of machine tools to be shown in course of manufacture by Bührle and Co. will include lathes, jig borers, drilling and gear cutting machines.

Micafil, Ltd., a company established in 1918, specialises in the manufacture of insulating materials for the electrical industry as well as capacitors, vacuum pumps and winding machines for all types of coils. Contraves, Ltd., was set up in 1936 as a research establishment into the subject of anti-aircraft artillery. In more recent years it has been particularly concerned with the development of guided missiles and their electronic equipment and devices mainly for military purposes.

The manufacture of textile machinery has long been an important branch of Swiss industry and the firms specialising in this class of plant included in the programme are Schweiter, Ltd., Zürich, manufacturers of preparatory machines for textile firms—and J. J. Rieter and Co., Ltd., Winterthur—makers of spinning machinery. In connection with textiles, the ladies will doubtless find particularly interesting a visit which has been arranged to the embroidery establishment of Bischoff Textiles, Ltd., in St. Gallen, where they will see Saurer machines in operation, and the well-known embroidery craft school. Other visits not of a strictly engineering nature include those to the works of Bally's Shoe Factories, Ltd., at Schöenenwerd ; the chocolate factory of Lindt and Sprüngli, Ltd., at Kilchberg-Zürich ; the Swiss China Clay Manufactory, Ltd., at Langenthal, and the cheese factories at Argovie and Lucerne.

Have you thought of designing in REFRACTORY CONCRETES?

The idea of "concrete" furnace construction may appear revolutionary, but it has already gained wide acceptance because concrete construction techniques allow the designer and builder to:

THINK IN TERMS OF Monolithic walls, roofs, hearths, etc., NOT brick by brick construction with its joint and other complications.

THINK IN TERMS OF High strengths before, during and after firing.

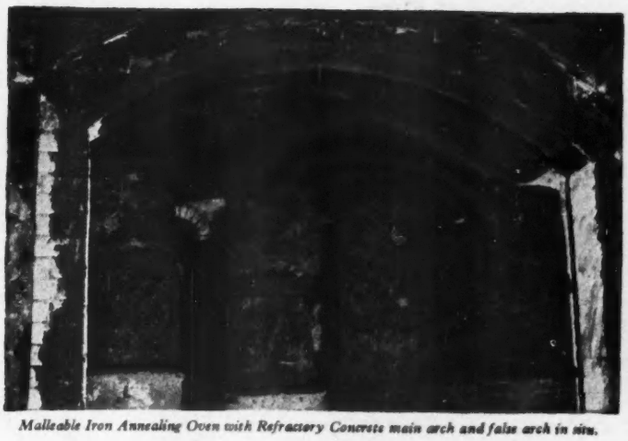
THINK IN TERMS OF Fast construction, smooth walls, easily constructed suspended roofs—all possible by concrete casting.

THINK IN TERMS OF Composite refractory and insulating structures cast in one piece—Refractory Concretes of varying refractoriness and thermal conductivity are easily made.

IN ADDITION

All Refractory Concretes have these points in common:

- **Flexibility of design**
- **Low cost of materials**
- **Low installation costs**
- **Avoidance of delay**



Malleable Iron Annealing Oven with Refractory Concrete main arch and false arch in situ.

There is a place for Refractory Concrete in every industry. Practically any shape or size of unit is possible by casting.

If you have an immediate problem write to our Technical Service Section.

CIMENT FONDU Reg'd Trade Mark ALUMINOUS CEMENT — up to 1350°C — **CASTABLE REFRACTORY CONCRETES** — up to 1800°C — SECAR 250 REGD. TRADE MARK

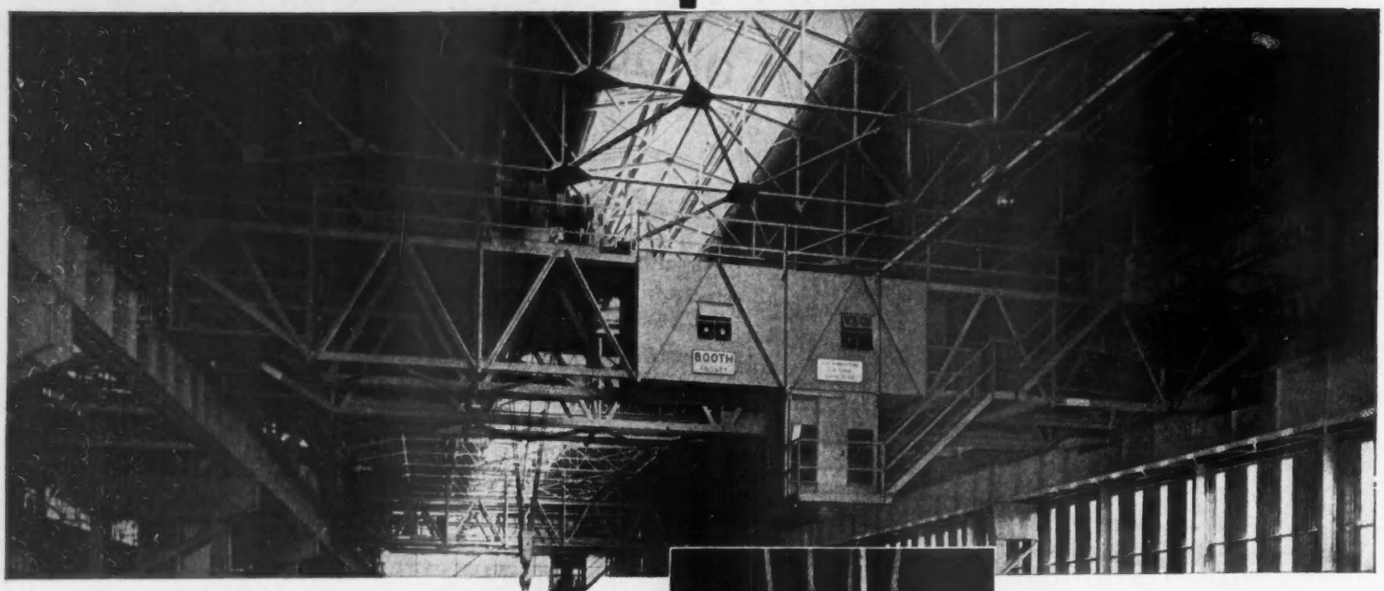
WRITE FOR BOOKLETS 'SECAR 250' AND 'REFRACTORY CONCRETE'

LAFARGE ALUMINOUS CEMENT CO. LTD. 73 BROOK STREET, LONDON, W.1. Tel: MAYfair 8546

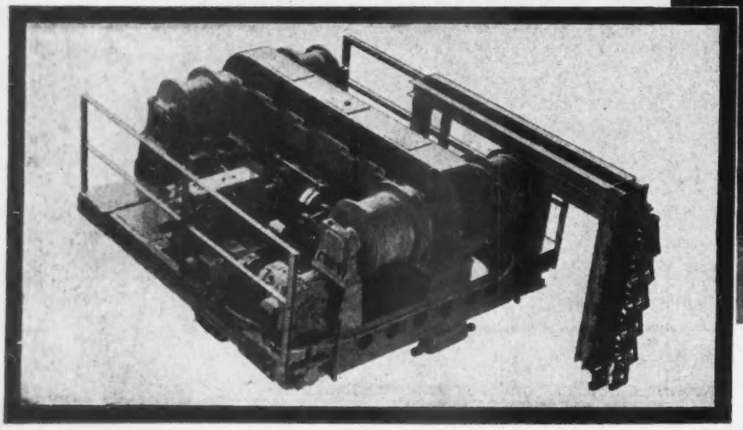
AP/33

CLYDE-BOOTH

CONTINUOUS PROCESS CRANES FOR STEELWORKS ETC.



(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Our publication "The Booth Handbook on Overhead Cranes" is available on request.

MANUFACTURERS OF

OVERHEAD TRAVELLING CRANES
TRANSPORTER CRANES DOCKSIDE CRANES
DIESEL RAIL CRANES SHIPS DECK CRANES ETC.

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.
Incorporating:

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Tel.: Pudsey 3168 (6 lines). Grams: "Cranes," Rodley, Telex. Telex 55159.

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire
Tel.: Holytown 412 (6 lines). Grams: "Clyde," Motherwell, Telex. Telex 77443.

DESIGNERS! THIS IS THE ONE REFERENCE BOOK TO SOLVE YOUR FLUID SEALING PROBLEMS — AND IT'S FREE!

When you design Fluid Seal applications, don't be without this valuable Reference Book issued by Pioneer. Prepared by practical engineers, it includes the latest up-to-date information on Fluid Seal Technology, comprehensive data on a wide variety of applications, how to install correctly with easy-to-follow illustrations for all the various types of seals produced by Pioneer, and a full range of available sizes. The Pioneer Reference Book which comes to you on request, is a practical work for the busy designer and is part of the Pioneer service which includes free advice on any Fluid Sealing problem.

Pioneer

OILSEALING & MOULDING CO. LTD

A DIVISION OF J. H. FENNER & CO. LTD

Factory and Head Office : Cottontree Works, Colne, Lancs. Tel : Wycoller 471 (8 lines)

GET YOUR COPY OF THE PIONEER FLUID SEAL CATALOGUE *NOW*

NORRIS BROS. LTD.

have teams available to undertake

DESIGN, DETAILING and DEVELOPMENT

in the following fields :-

Aeronautical Engineering
Chemical Plant
Electrical Engineering
Mechanical Engineering
Mechanical Handling
Model Making
Nuclear Engineering
Plant Layout
Production Tooling
Servo Mechanisms, Automation
Special Machines and Projects
Structure and Reinforced Concrete, etc.

53 VICTORIA STREET S.W.1
– TEL. ABBEY 6132 –

ABBOTT & CO.

(NEWARK) LTD.
Newark Boiler Works
NEWARK · NOTTS
Telegrams : ABBOT NEWARK 34
Telephone : NEWARK 34

BOILERS and AIR RECEIVERS

See Display Advertisement June 5

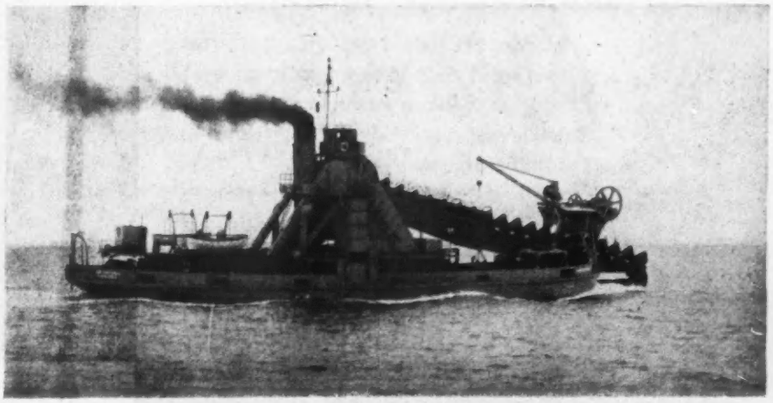
DREDGING PLANT

To the Largest Dimensions and Capabilities.

PATENT CUTTER HOPPER DREDGERS PATENT DIPPER DREDGERS, BUCKET DREDGERS, GOLD & TIN RECOVERY DREDGERS, FLOATING CRANES.

Hopper Barges, Screw Steamers, Side and Stern Paddle Wheel Steamers, Tugs, etc.

New Buckets, Links, Pins, Gearing, etc., supplied for existing Dredgers.

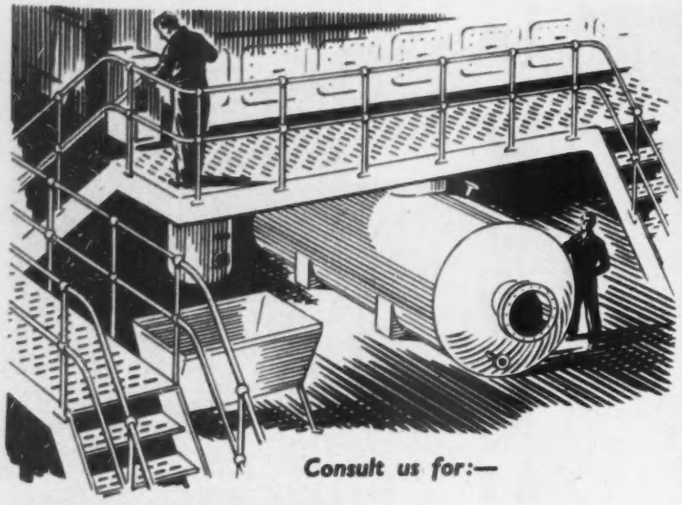


Twin Screw Bow Well Bucket Dredger "Abertawe" constructed for the Great Western Railway Company. Dimensions: 160ft. x 40ft. x 14ft. Speed: 8½ knots. Buckets : 27 cub. ft. Specified Dredging Output : 900 tons per hour.

FLEMING & FERGUSON LTD.

Phone : Paisley 4121 SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND. Tel. Add. "Phoenix Paisley."

London Agents : Messrs. NYE & MENZIES Ltd., Capel House, 62, New Broad St., E.C.2 Phone: London Wall 4046



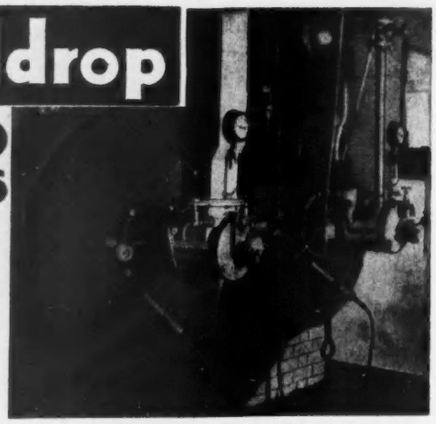
Consult us for:—

OPEN STEEL FLOORING
TUBULAR HAND RAILING & STANDARDS
STEEL PLATFORMS & STAIRCASES
TANK WORK
PRESSED STEEL GUTTERS
GENERAL PLATE WORK & FABRICATIONS

E. HAYWARD & CO. (Fabrications) LTD.
POUNTNEY STREET · WOLVERHAMPTON
Telephone No.: Wolverhampton 23300

Schieldrop

OIL FIRED BOILERS



We Guarantee
13½ to 14 per cent CO_2 with Shell Smoke number 4 or less.
Write for Catalogue quoting Reference A/11

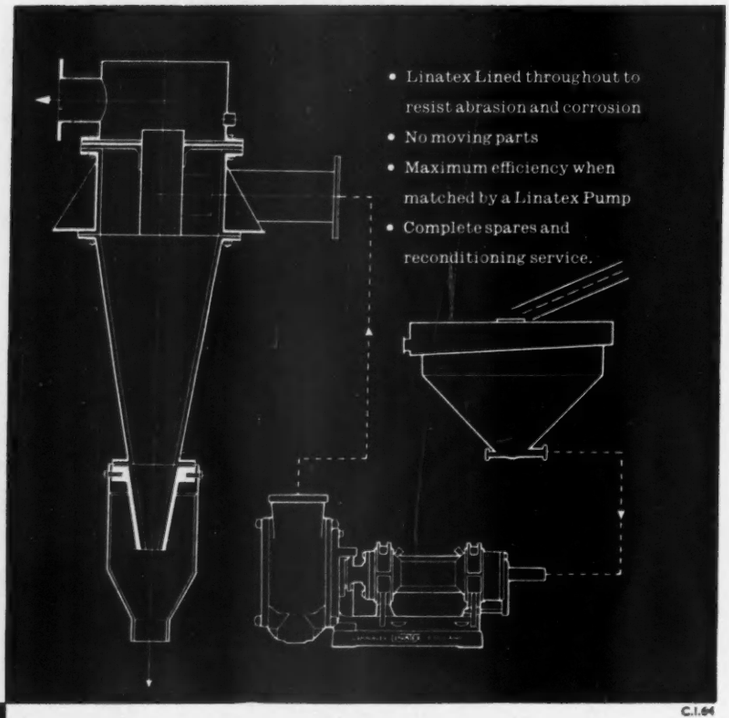
Schieldrop & CO. LTD
STOTFOLD, BEDS. Tel. 414 (4 lines)
OFFICE: AT: BIRMINGHAM · LONDON · MANCHESTER SWANSEA · GLASGOW

MAKERS OF GEARBOXES FOR 40 YEARS

ALBION ENGINEERING CO. LTD.
SAMPSON ROAD NORTH, BIRMINGHAM, 11
Telephone: Birmingham Victoria 4064

DISPOSAL OF FINES,
DE-WATERING
OR THICKENING?
. . . just the job for a
LINATEX separation system

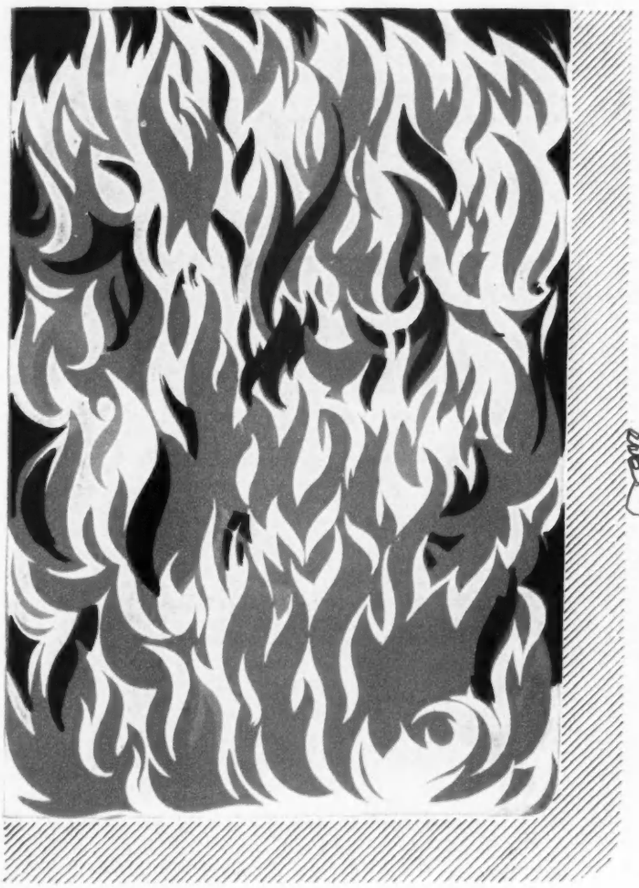
Linatex are indeed well qualified to offer this service. It is based on long, world-wide experience of separating and de-watering materials in the sand and mining industries.
Are you thinking of a complete plant? Or do you wish to know how Linatex units can be used in existing installations? Consult our resident area engineer or ask for a proving test on our pilot plant.


• Linatex Lined throughout to resist abrasion and corrosion
• No moving parts
• Maximum efficiency when matched by a Linatex Pump
• Complete spares and reconditioning service.

C.I.64

THE LINATEX ORGANISATION
A WORLD-WIDE SERVICE TO INDUSTRY

WILKINSON RUBBER LINATEX LTD · CAMBERLEY · SURREY · Tel: Camberley 1595 · *Factories and distributors throughout the world*



holding heat in its proper place . . .

GREENWICH INSULATION COMPANY LTD

FOR THERMAL INSULATION OF ALL TYPES

The Cutty Sark, berthed near our wharves at Greenwich

In addition to the skilled application of traditional materials the company is actively engaged in the development of techniques using the many new materials now available to industry.

Hart's Wharf, Norman Road, Greenwich, London S.E.10 Telephone: GREenwich 4851/3

ONE OF THE RBH GROUP

H

*Are you on our Mailing List for high quality cables at competitive prices?

BICC GROUP

CABLEMAKERS IN THE UNITED KINGDOM

British Insulated Callender's Cables Ltd.
21 BLOOMSBURY STREET, LONDON, W.C.1

Connollys (Blackley) Ltd. (Cables Division)
MANCHESTER, 9

W. T. Glover & Co. Ltd.
TRAFFORD PARK, MANCHESTER, 17

The Metropolitan Electric Cable & Construction Co. Ltd.
CLYDE WORKS, CHADWELL HEATH, ESSEX

St. Helens Cable & Rubber Co. Ltd.
SLOUGH, BUCKS

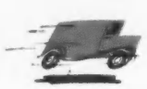
The Telegraph Construction & Maintenance Co. Ltd.
MERCURY HOUSE, THEOBALDS ROAD, LONDON, W.C.1

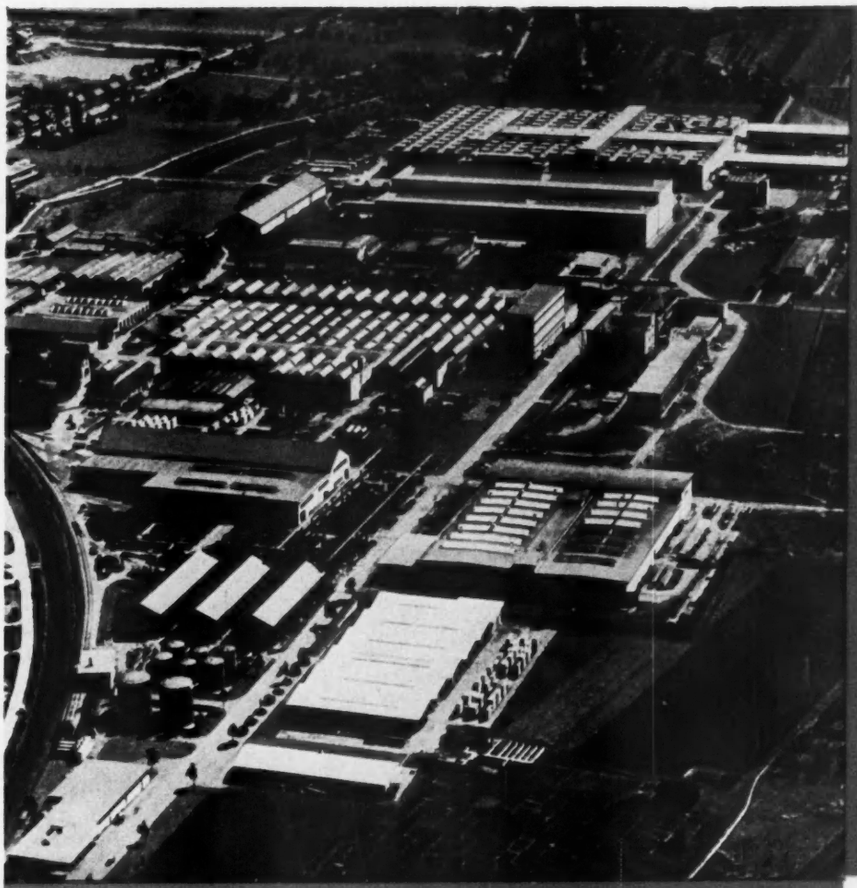
RUBBER
PLASTIC
PAPER
MINERAL

Price Lists mailed direct to you on application to any of the above Companies

Prompt deliveries from **89** *Branch Offices or from your regular wholesaler*

Technical Advisory Service by Qualified Engineers





Sulzer Works Oberwinterthur

SULZER

Sulzer Brothers Limited extend a hearty welcome to the members of the Institution of Mechanical Engineers

OUR PRODUCTION RANGE:

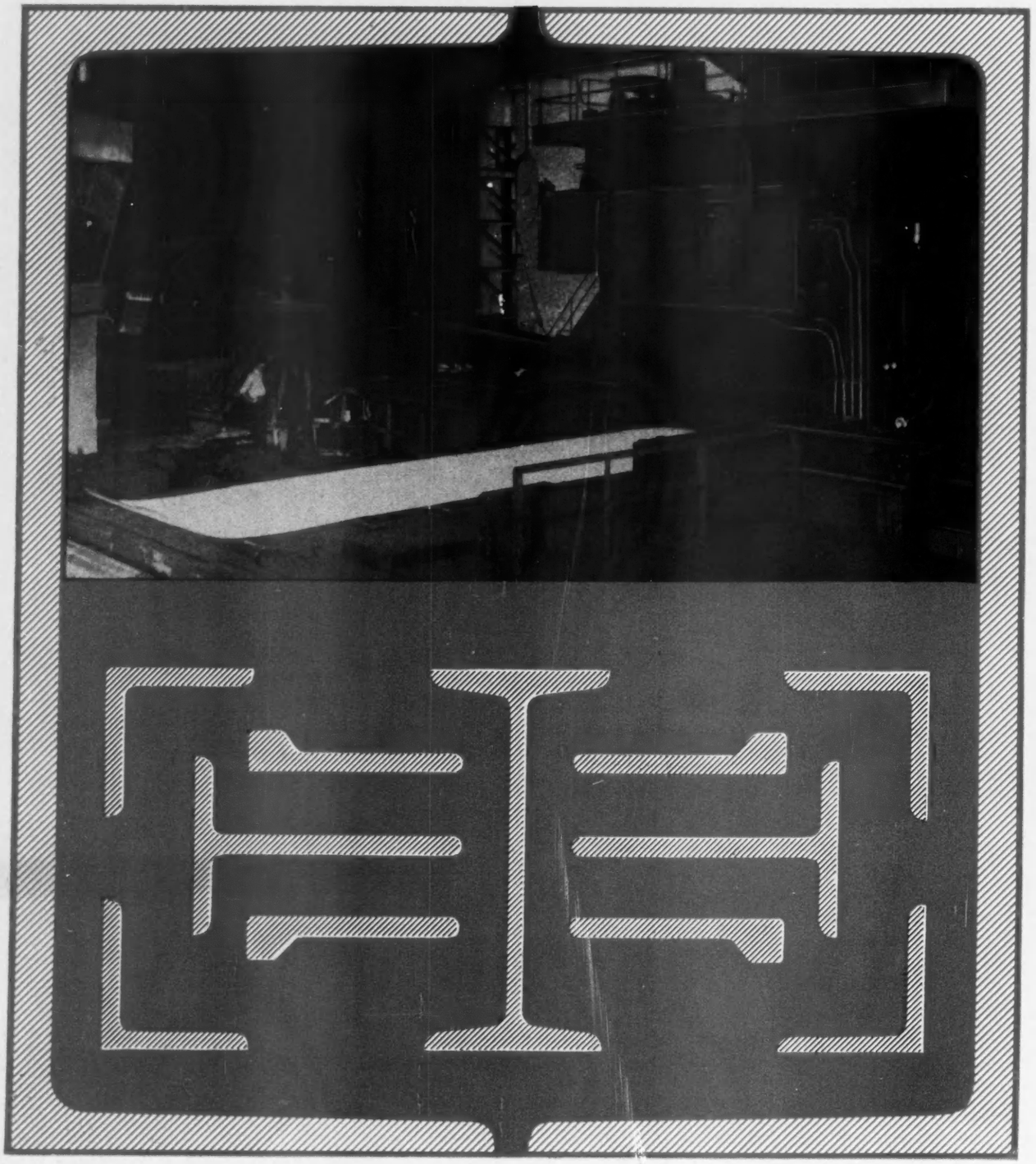
Diesel engines · Steam boiler plants · Reactor plants for nuclear power stations · Gas turbine plants. Steam turbines · High-pressure pipe lines · Pumps. Turbo and piston-type compressors · Fans · Refrigerating plants · Heating and air conditioning installations. Processing plants · Weaving machine plants · Foundry products.

SULZER BROTHERS LIMITED

Winterthur, Switzerland

APPLEBY-FRODINGHAM

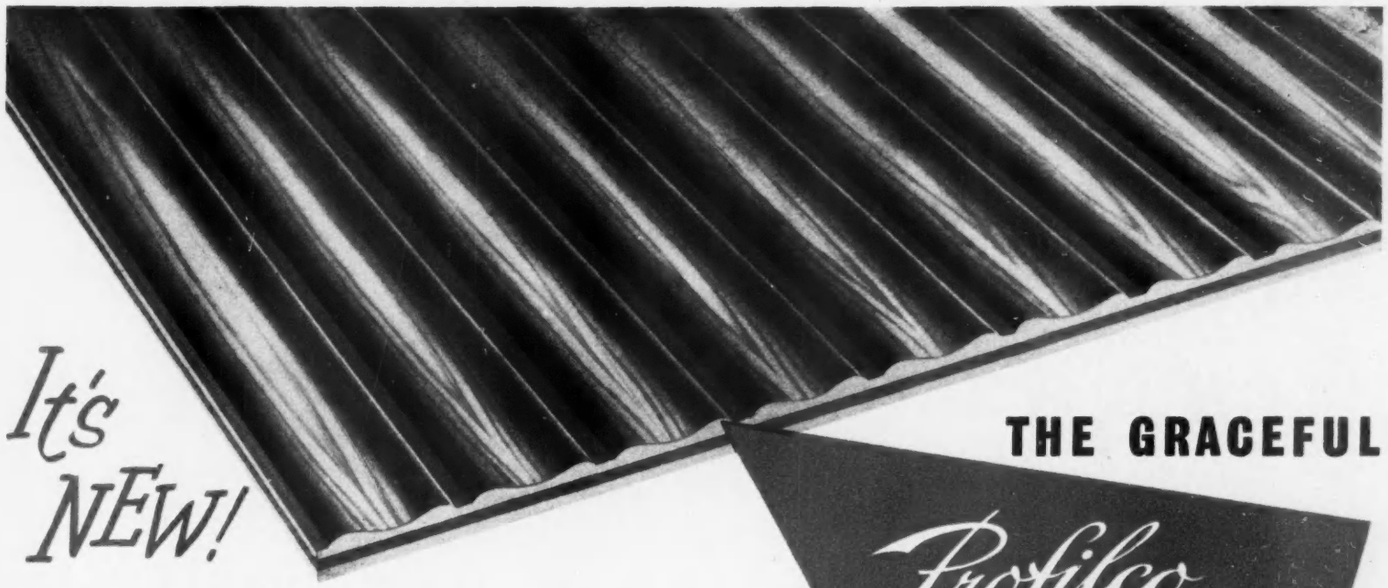
PLATES & SECTIONS



APPLEBY-FRODINGHAM STEEL COMPANY • SCUNTHORPE • LINCOLNSHIRE
A Branch of The United Steel Companies Limited

THE UNITED STEEL COMPANIES LTD

AF167



It's NEW!

THE GRACEFUL

Profilco

PANELLING

The PROFILCO panelling is a Plywood made from three layers of 2.5mm. Utile Mahogany veneers. Bonding A-70 and AX-100. The face veneer has a most attractive profiling and the edges of the boards have been moulded in such a way that, when joined together, the joints cannot be noticed.

The PROFILCO boards are carefully sorted in order to attain a uniform appearance.

A natural oil finish or cellulose lacquer finish is recommended.

Samples and prices on application.

THICKNESS : $\frac{5}{16}$"

STANDARD SIZES :

A-70 Bonding

5′ × 2′ 6′ × 2′

7′ × 2′ 8′ × 2′

AX-100 Bonding 8′ × 2′

Packed 15 boards to a bundle.

C. F. ANDERSON & SON LTD.

TIMBER AND PLYWOOD IMPORTERS

ISLINGTON · LONDON · N.1.

Tel: CANonbury 1212 (28 lines)

A NEW AND IMPROVED RANGE of CORROSION RESISTING CEMENTS

with

Improved Resistance,

Greater Adhesion,

Lower Porosity,

Longer Life,

Greater Compressive Strength

For use on all corrosion resisting constructions

Pickling Tanks,
Neutralising Tanks,
Piers & Tank Bases,
Acid Resisting Floors,
Channels, Sumps etc.

Covered by World Patents

Manufactured exclusively in Great Britain by:—

PRODORITE LTD

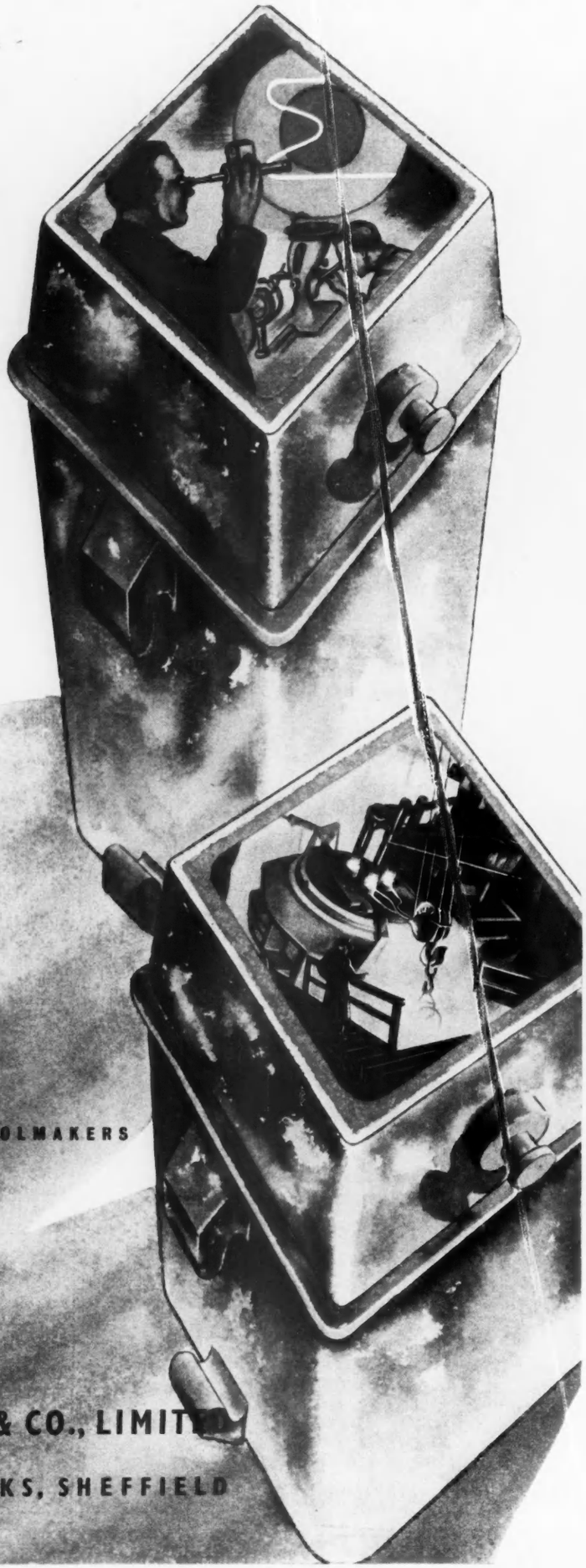
EAGLE WORKS

WEDNESBURY

TELEPHONE : WED 1821 9 lines

WRITE NOW FOR OUR BROCHURE ON THIS NEW AND IMPROVED RANGE OF CORROSION RESISTING CEMENTS

IN EVERY INGOT . . .



. . . cast from the furnaces of the *Osborn* group of Companies, cumulative experience from generations of craftmanship is combined with modern research and technology to produce steel of superlative quality. A wide range of high-speed and other special tool steels is manufactured and many other products including steel castings, forgings and engineers' cutting tools are produced within the same organisation.

STEELMAKERS

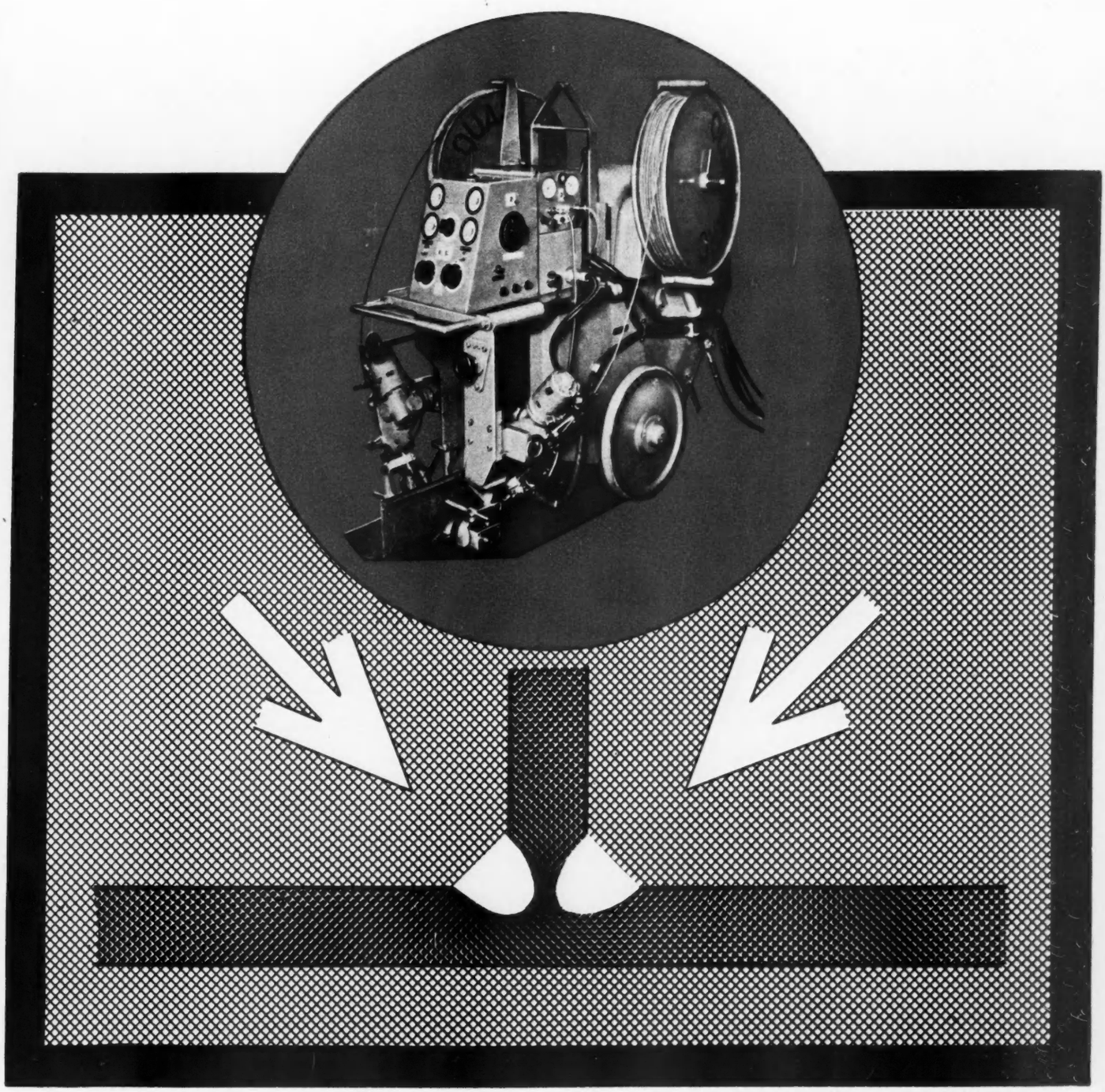
STEELFOUNDERS

ENGINEERS' TOOLMAKERS

OSBORN

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD



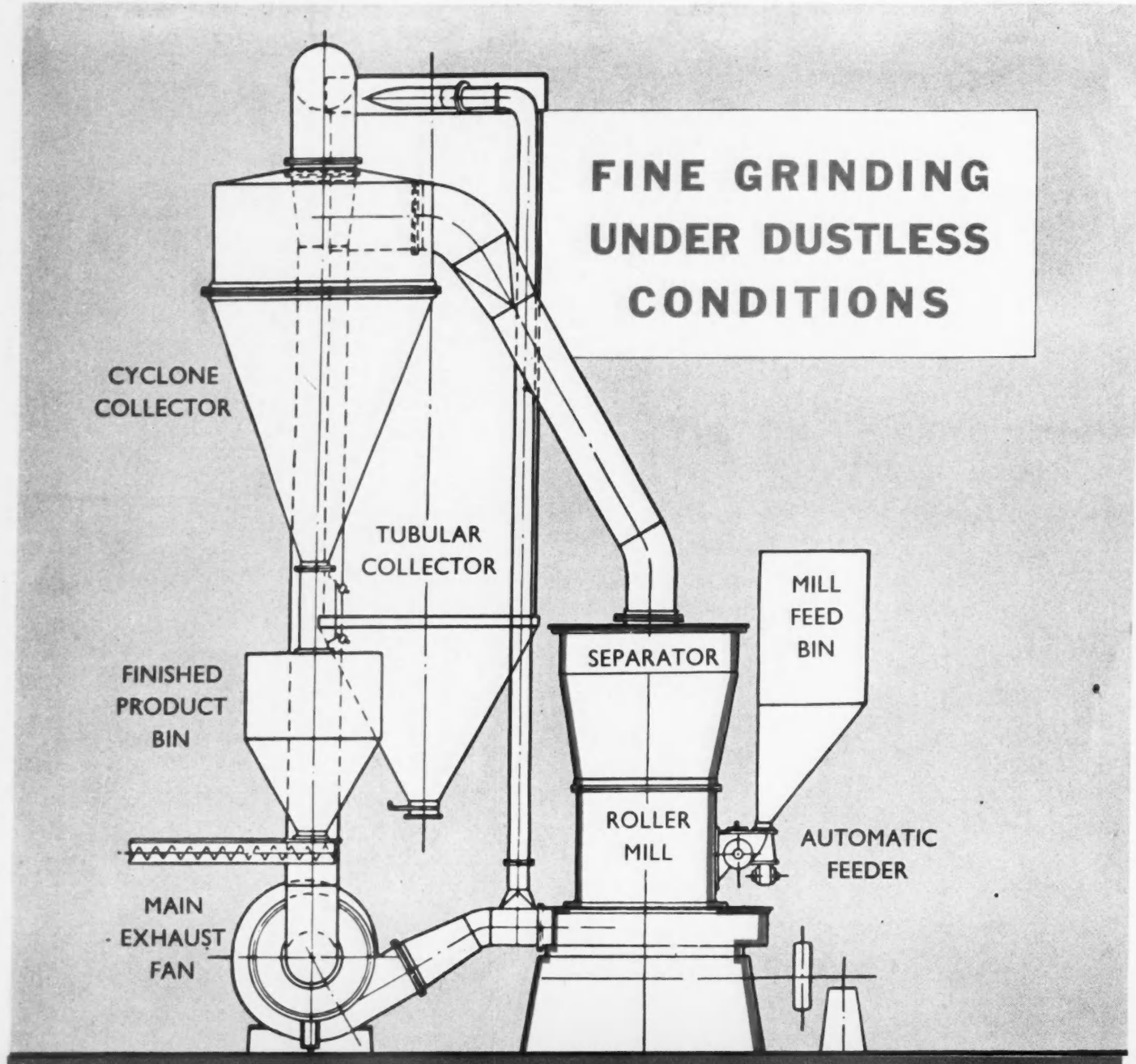
New Quasi-Arc twin-fillet welder gives another boost to production

Following the success of the automatic welding gantries, Quasi-Arc now introduce another new machine for simultaneous twin-fillet welding in shipyards or engineering works. Light, easily manœuvrable, and quickly set up, the Twin-Fillet Welder will produce 800 ft. or more of 5/16″ fillet per shift. Two FUSARC/CO_2 welding heads mounted on a self-propelled carriage are *guided automatically* along the seam, giving smooth, deep-penetration welds with first-rate slag detachability.

For full details of these and many other new features write to Quasi-Arc Limited, Bilston, Staffs.

Quasi-Arc **world leaders in arc welding**

Quasi-Arc Limited, Bilston, Staffordshire



RAYMOND ROLLER MILLS

Grinding by centrifugal action of pendulum rollers against grinding ring • Automatic feeder and integral air classification system • Suction fan at floor-level draws the ground material to a separator and thence direct to a cyclone • Dustless pneumatic system conveys and collects product • High output of final ground material ranging to 325 mesh as desired.

IC

INTERNATIONAL COMBUSTION PRODUCTS LIMITED

Member of Atomic Power Constructions Limited. One of the five British Nuclear Energy Groups.

NINETEEN WOBURN PLACE, LONDON W.C.1 TELEPHONE: TERMINUS 2833

WORKS: DERBY, ENGLAND.

TG2 RM6 A

'HARCO'

PERFORATED MILD STEEL

CABLE TRAYS

provide a continuous chassis for the efficient attachment of cables and wires. With the Cable Trays once in position, subsequent alterations and additions to the wiring can be speedily effected at minimum cost, without drilling or plugging.

Trays and bends are available from 2 in. to 36 in. wide; the standard length of trays is 8 ft.

Strongly constructed of mild steel plate, and supplied self-colour, painted, hot-dip galvanized or plastic coated as required.

Send for List No. 1003 to:

G. A. HARVEY & CO.
(LONDON) LTD.
WOOLWICH RD., LONDON, S.E.7
Telephone: GREenwich 3232 (22 lines)

HARVEY

Other HARVEY Facilities and Products: PERFORATED METALS · WOVEN WIRE · WIREWORK · LARGE MACHINE SHOP FACILITIES · FABRICATIONS IN ALL METALS · STEEL SHELVING AND STORAGE EQUIPMENT · GALVANIZING · ETC.

P/6

HAMMERED OR HYDRAULIC PRESSED

FORGINGS

IN STEEL
BLACK OR MACHINED
TO 24 TONS

THE INCE FORGE CO. LTD.
WIGAN
PARKS FORGE LTD. PROPRIETORS

WOVEN WIRE

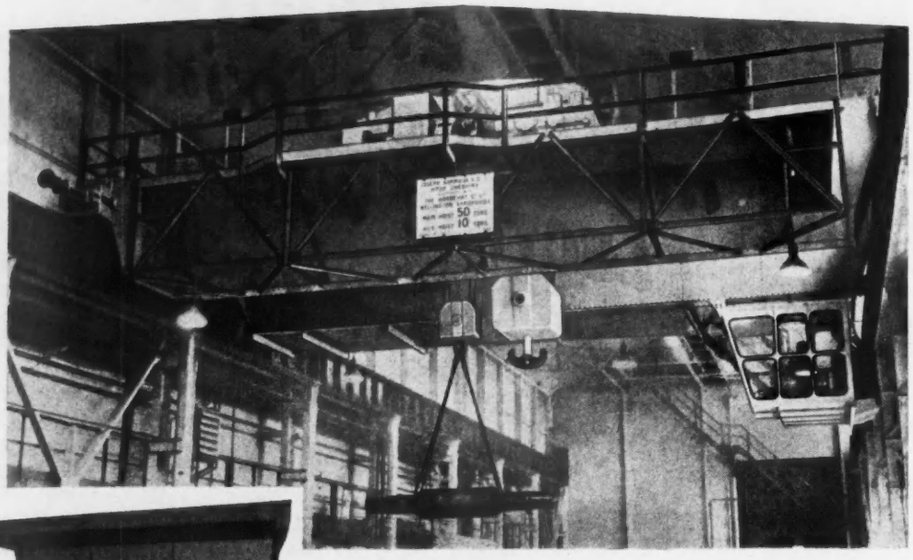
F. W. POTTER & SOAR LTD

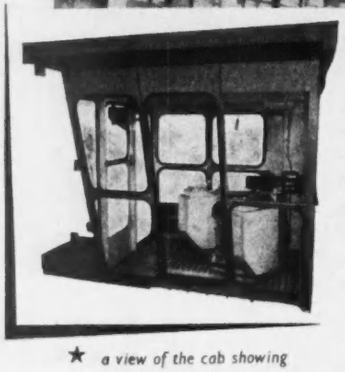
Made in ALL METALS,
Our range of Weaving covers all grades
from the FINEST WIRE CLOTH
to the HEAVIEST SCREENING.
A.I.B. and A.R.B. approved

Please write for our Brochure, containing useful Technical information.

PHIPP STREET
LONDON E.C.2

JOSEPH ADAMSON
ELECTRIC OVERHEAD TRAVELLING CRANES





★ *a view of the cab showing the seat control unit.*

The Adamson 50/10 ton crane is the third of a series of new design supplied to Richard Thomas & Baldwins Limited, Ebbw Vale Section. Features of the crane include monolithic construction of the crab and the elimination of castings by mild steel fabrication of the hoist barrel and bottom block. The cab is of particular interest as it incorporates the most modern type of seat unit ensuring maximum vision and ease of control. Joseph Adamson electric overhead travelling cranes can be supplied to all specifications including cranes suited to the most exacting 24 hours-a-day process work.

JAC

JOSEPH ADAMSON & CO. LTD.
P.O. BOX 4 · HYDE · CHESHIRE

in association with
Adamson Alliance Co. Ltd., 165 Fenchurch St., London, E.C.3
Horsehay Co. Ltd., Wellington, Salop.

THE ADAMSON GROUP

JA. 25

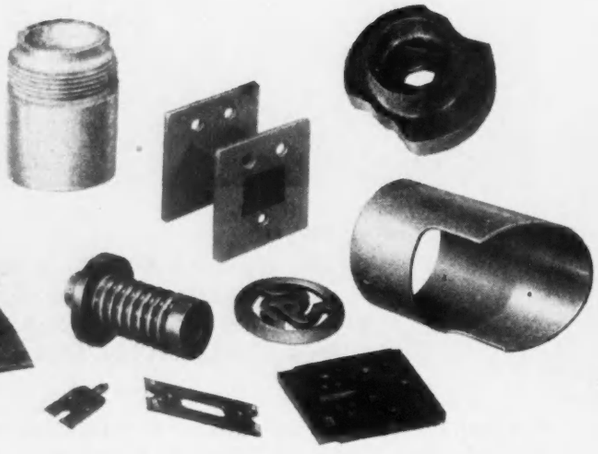
LIGHT IN WEIGHT, TOUGH, AND DURABLE WITH GOOD ELECTRICAL PROPERTIES

CAN BE MOULDED, PUNCHED AND MACHINED

SUITABLE FOR COUNTLESS ELECTRICAL AND MECHANICAL APPLICATIONS

That's PAXOLIN

M & I make PAXOLIN synthetic resin bonded materials in a wide range of grades with paper, fabric, asbestos, glass and other fillers. It is supplied in the form of sheets, tubes and cylinders as well as punched, moulded and machined parts. If you would like to know more about Paxolin, write or 'phone for descriptive literature.



Examples of Paxolin punchings, mouldings and machined parts.

the electrical insulation people

m and i

THE MICANITE & INSULATORS CO., LTD.,
Blackhorse Lane, Walthamstow, E.17. Tel: Larkswood 5500.
Grams: Mytilite, London, Telex. Telex: 25183.

"PAXOLIN" is a registered trade name of The Micanite & Insulators Co., Ltd.

TWIN OR MULTIPLE WORM BIN DISCHARGER

TAPERED OR VARIABLE PITCH WORMS DRIVEN BY AN ELECTRIC MOTOR TO REGULATE THE FLOW OF MATERIAL FROM STORAGE BINS. SIZES TO SUIT ANY LAYOUT.

W. S. BARRON & SON LTD.
GLOUCESTER

Manufacturers with over 50 Years' experience — Offer the latest in
CRUSHING · GRINDING · MIXING
FEEDING · SIEVING
MACHINERY

THE MOST PRACTICAL WAY OF ELEVATING BULK MATERIAL AND OFFERING THE BEST POSSIBLE PROTECTION AGAINST FIRE AND EXPLOSION RISK.

•

1 to 50 tons per hour Capacities

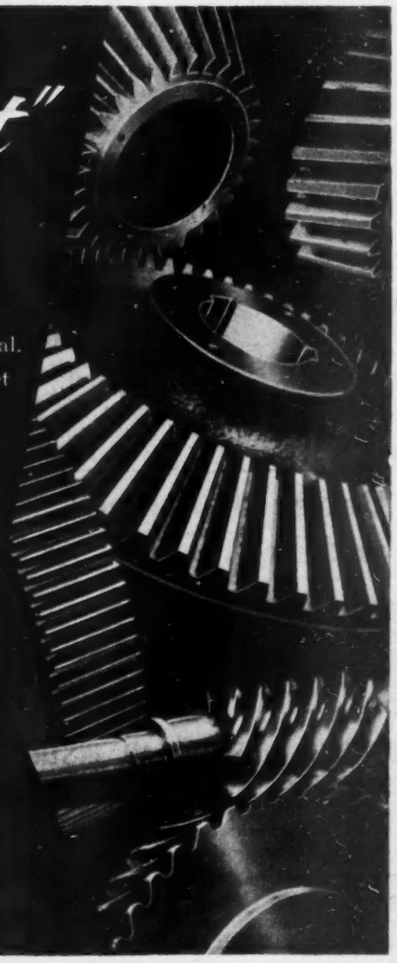
Screw-Lift

PATENTED AND TRADE MARK REG. U.S. PAT. OFF.

Phone: Gloucester 21055-6-7

"I can help you out"

Whether you are a large or a small gear user, you will find the same efficient and helpful service at our Stonebridge Park Works. The advice of experts is always at your disposal. Whatever the quantities involved, we can meet your requirements exactly, with quick deliveries at competitive prices. Spur, helical, bevel and worm gears for every industrial purpose. Comprehensive Catalogue No. E.400-2 sent on request.



SPUR GEARS BEVEL GEARS
HELICAL GEARS WORM GEARS

THE **DAVID BROWN** CORPORATION (SALES) LIMITED
LONDON GEAR DIVISION Stonebridge Park Works Nth Circular Rd London NW10 Elgar 6824

If it's { AWKWARD / BULKY / HEAVY (up to 25 tons)

ARUPS

can lift and move it

Lorry mounted, tracked and mobile cranes from 2 - 25 tons. For hire anywhere in U.K. Jib lengths up to 120 ft plus 30 ft. fly jib. Work also carried out on contract.

Coles Model L3010 25 ton crane

***phone GERRARD 2708** (5 LINES)*

ARUP & ARUP LTD., COLQUHOUN HOUSE, BROADWICK ST., W.1

VEE - REG

Regulating/Stop

GLOBE VALVES

FITTED WITH
'V' PORTED STAINLESS
STEEL CLACK & SEAT

• • •

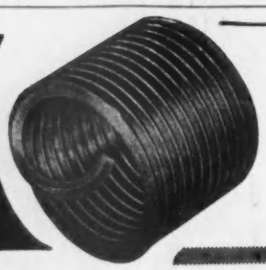
In Bronze & Steel for Pressures up to 900 P.S.I. and 900° F.

• • •

WRITE FOR CATALOGUE TO :—

THE BRITISH STEAM SPECIALTIES LTD.
FLEET STREET
LEICESTER

Better than New with a . . . .

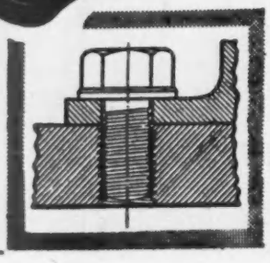


Cross

BRITISH WIRE THREAD INSERT

PRECISION MADE in CARBON STEEL
for ALUMINIUM and MAGNESIUM.

We also make Stainless and Bronze for other applications.



CROSS MANUFACTURING CO. (1938) LTD.

Tel: Combe Down 2255-6 BATH, SOMERSET Grams: Circle, Bath

Specialists in JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS, etc.

TWO-STAGE OIL FREE AIR COMPRESSOR

The machine illustrated is of single-crank, single-acting, two-stage, inverted trunk piston design, non-lubricated type and capable of delivering 200 c.f.m. at 120 lbs. p.s.i. pressure. It is fitted with stainless steel valve plates, ni-resist liners, gun-metal carriers for the carbon piston rings, aluminium pistons and special dry fabric filters. The neat integral intercooler should be noted; this reduces the floor space occupied by the machine and in addition to the intercooler and cylinders, the cross head is also water cooled.

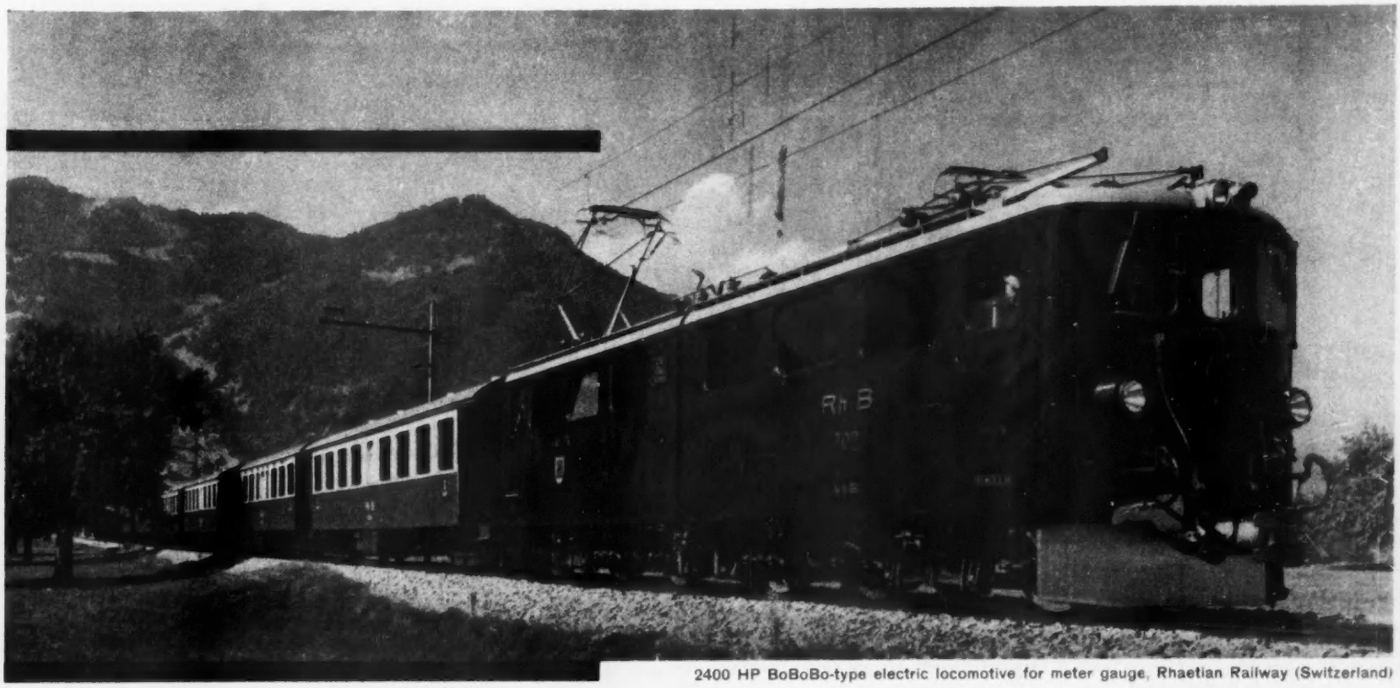
TILGHMAN'S LIMITED

A member of the Staveley Coal and Iron Co. Ltd. Group.

BROADHEATH ALTRINCHAM CHESHIRE

LONDON OFFICE: 1 Chester Street, S.W.1.

W.214



2400 HP BoBoBo-type electric locomotive for meter gauge, Rhaetian Railway (Switzerland)

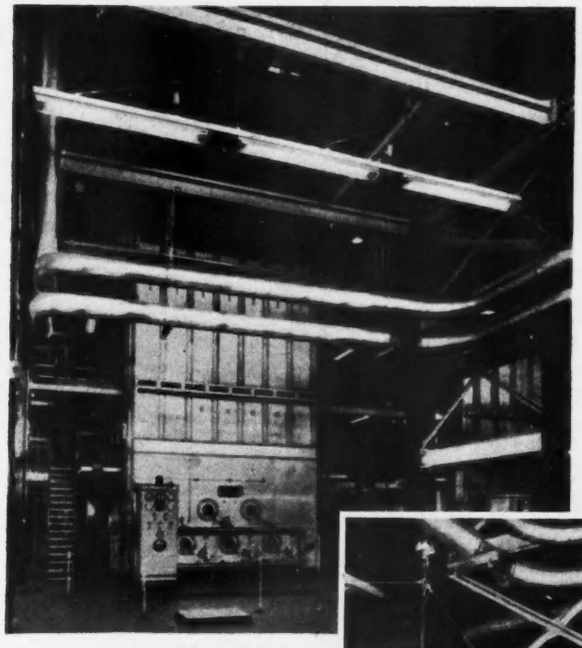
SLM

Our products:

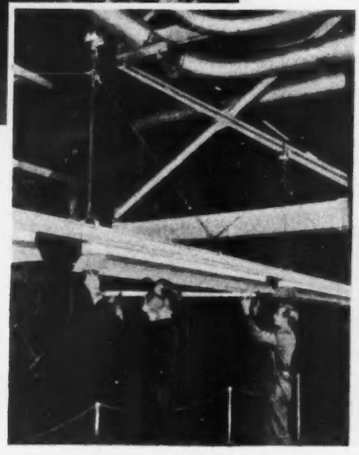
Electric, Diesel and steam locomotives of every type and for any gauge.
Oil-operated gears for rail vehicles, and also reduction and reversing gears for ships.
Diesel engines, gas engines, dual-fuel engines, gas producers.
Rotary compressors, vacuum pumps, water-ring pumps, Roots blowers, gas compressors and gas storage plants.
Steam boilers.
High-pressure oil pumps with constant delivery and automatic quantity regulation.

4234

Swiss Locomotive and Machine Works Winterthur



Fluorescent Trunking in the boiler house at Vauxhall Motors, Luton.



Here the lights have been lowered by means of L.E.F. gear for servicing at a convenient height.

TIB 125

OUT-OF-REACH LIGHTING . . .

You need
L.E.F. Raising and Lowering Gear

When servicing lights, don't incur heavy labour costs and risk accidents with ladders and improvisations. With L.E.F. Raising and Lowering Gear lights can be quickly brought down to a convenient level and raised again when the work is finished. L.E.F. gear is suitable for both interior and exterior lighting — and soon pays for itself through lower maintenance costs.

We shall be glad to send you full details or give you a demonstration at our works.

. . . TO BE SERVICED ?

L&F

LONDON ELECTRIC FIRM LIMITED
Brighton Road, South Croydon, Surrey.
Telephone: Uplands 4871

G·G·L

We all know this man. He's the chap who has just tried GGL for the first time and can't stop talking about the wonderful quality and service. He's a nice man, really, but he does go on . . . and it isn't as if we old stagers didn't rely on GGL service, too.

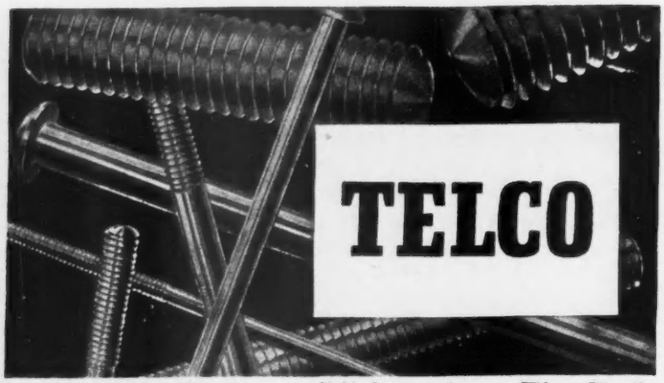
CAPSTAN AND AUTOMATIC WORK AND SHEET METAL PRESSING IN ANY METAL, ANY FINISH, ANY QUANTITY

FOR QUICK SERVICE AT THE RIGHT PRICE GET IN TOUCH WITH:

GRIFFITHS, GILBART, LLOYD & CO. LTD.

EMPIRE WORKS, PARK ROAD, BIRMINGHAM, 18

TEL: NORTHERN 6221



Studding · Studs · Allthreads · Tie Rods

TELCO LTD., 3 Newman Street, London, W.1 MUSeum 5701/4

SIRRON

Diesel Engines

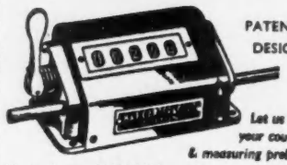
Main Propelling Diesel Engines in powers up to

1,200 H.P.

THE NEWBURY DIESEL CO. LTD.
NEWBURY, BERKS

ALBION

Ratchet and Revolution Counters



PATENTED DESIGN

Let us solve your counting & measuring problems

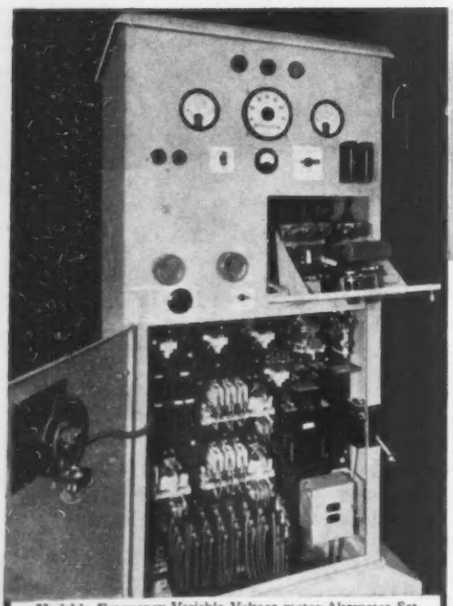
There is an 'ALBION' ratchet or revolution counter for every application. Fit your machines with these efficient counting instruments which will show your output at a glance.

INSTRUMENT DIVISION

B. & F. CARTER & CO. LTD.

BOLTON 3, ENGLAND

'Phone: BOLTON 4344 (3 lines)
'Grams: BRAIDERS BOLTON

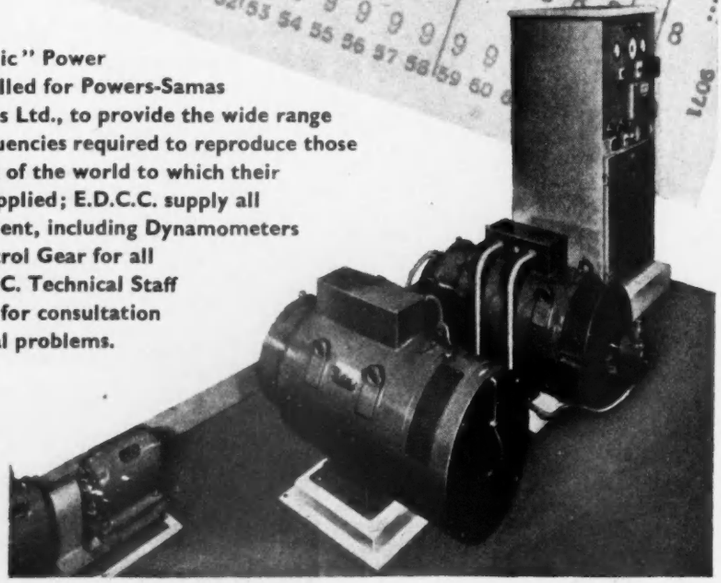


Variable Frequency Variable Voltage motor Alternator Set. Control Panel illustration shows Electronic Servo Regulator withdrawn for inspection.

Input	400 volts 50 cycles 3 phase
Output	10 kVA single phase
Voltage range	100/250 controlled ± 3%
Frequency range	65/25 cycles stabilized electronically within ± 0·5% of set value

universal power plant

An "Electro-Dynamic" Power Plant has been installed for Powers-Samas Accounting Machines Ltd., to provide the wide range of voltages and frequencies required to reproduce those obtained in any part of the world to which their machines may be supplied; E.D.C.C. supply all types of test equipment, including Dynamometers and Automatic Control Gear for all applications. E.D.C.C. Technical Staff are always available for consultation on customers' special problems.



Photographs by courtesy of Powers-Samas Ltd.

ELECTRO-DYNAMIC CONSTRUCTION CO LTD

ST. MARY CRAY, KENT Telephone: ORPINGTON 27551 Telegrams: Elodamic St. Mary Cray

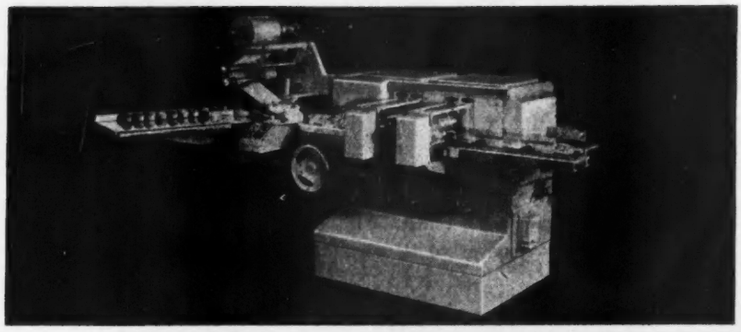
Control Gear Division
BRIDGWATER, SOMERSET
Telephone: Bridgwater 2862

Glasgow Office
40 HOULDSWORTH ST., C3
Telephone: Central 2620

Our manufacturing programme:

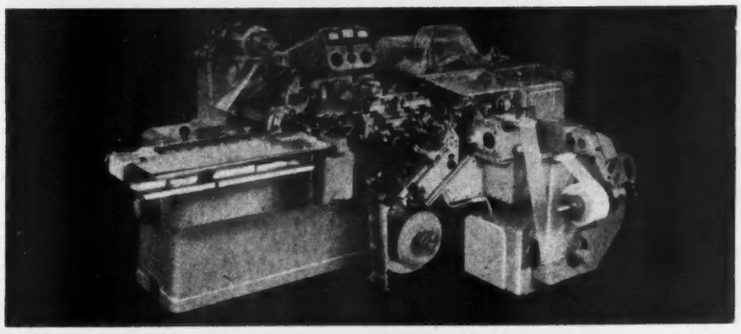
Railway Rolling Stock **Small Arms**
Packing Machines **Machine Tools**
Screw Pumps **Hydraulic Control Units**
Pneumatic Tools **Industrial Vehicles**

SIG



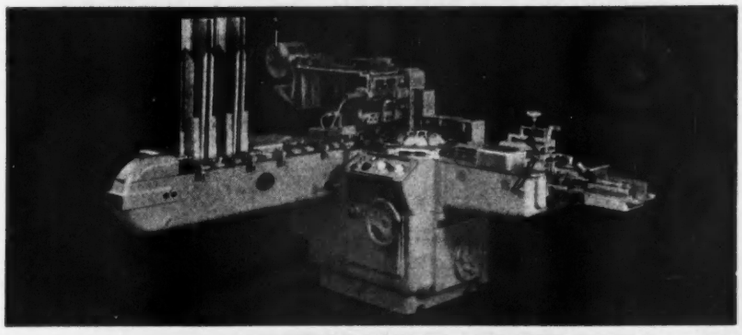
The excellent reputation enjoyed by SIG as manufacturers of well-designed, fast and robust packing machines capable of standing up to strenuous service over long years accounts to the fact that a large number of SIG machines operate in many leading food factories in the United Kingdom. In addition to manufacturing wrapping machines of varied types, SIG are also paying very particular attention to the important field of fully automatic packaging machines, being in a position to supply equipment of first order.

◀ Universal cello-wrapping machine type HSU, speed up to 200 wrappings per minute



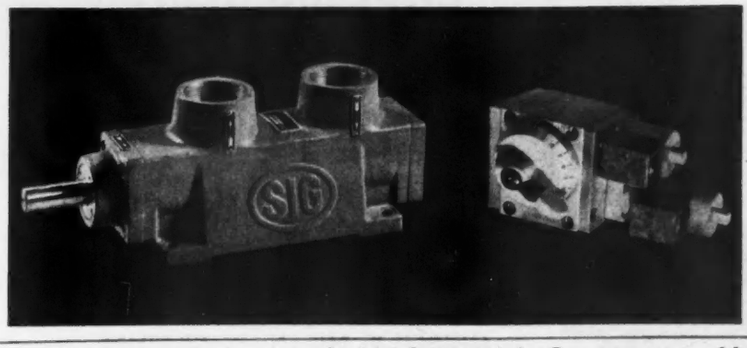
In the confectionery field SIG are in the position of furnishing high speed wrapping machines of highest technical perfection for hermetically wrapping chocolate tablets and bars. A special design evolved by SIG particularly for the United Kingdom is embodied in the jelly block wrapping machine.

◀ Two-stage machine type DSR for hermetically wrapping chocolate bars and tablets; output 140 wrappings per minute



A further line of equipment for which SIG claim world leadership is that of biscuit wrapping machines. Among these the machines for the wrapping of Cream Crackers deserve special mention.

◀ Latest wrapping machine type HBZ for biscuit snack packs; output 160 wrappings per minute



SIG Screw Pumps are built for pressures up to 2500 p.s.i. They are chiefly intended for handling all kinds of oils; but other liquids and semi-liquids, such as chocolate paste, can also be pumped on specially adapted types.

◀◀ Type ND low pressure pump up to 280 p.s.i.

SIG Hydraulic Control Equipment is built for embodiment in machine control systems.

◀ Type MA feed control unit with flow regulation

For further information apply to: **Swiss Industrial Company · Neuhausen - Rhine Falls · Switzerland**

LOCOMOTIVES

Designers and Builders of Steam, Diesel and Diesel-electric and Battery Locomotives for all purposes. Flame Proof Diesel and Battery Locos for underground working.

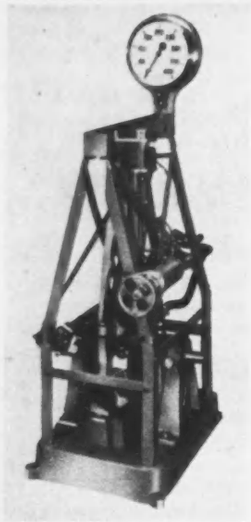
HUDSWELL, CLARKE & COMPANY LIMITED

Railway Foundry, Leeds

LONDON OFFICE:
14, Howick Place, Victoria Street, S.W.1

TELEPHONE:
Victoria 6786

The WILLS DYNAMOMETER

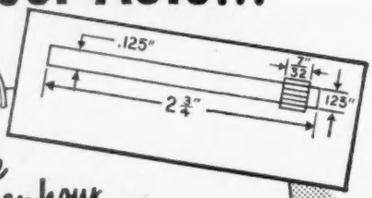


Designed for testing small low powered machines— covering a range of speeds up to 1500 r.p.m. and 15 b.h.p.

1. Can be run clockwise or anti-clockwise
2. Load can be varied whilst machine is running.
3. Hydraulic operation enables very accurate readings to be obtained
4. Can be run at any speed up to 1500 r.p.m.

W. & F. WILLS LTD.
(ENGINEERS)
BRIDGWATER · SOMERSET · ENGLAND.

79% Production Increase from Your Auto...



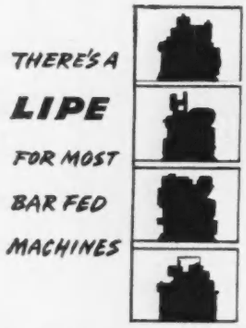
Conventional Auto Time 540 per hour
'LIPE' Time 969 per hour!

LIPE PNEUMATIC

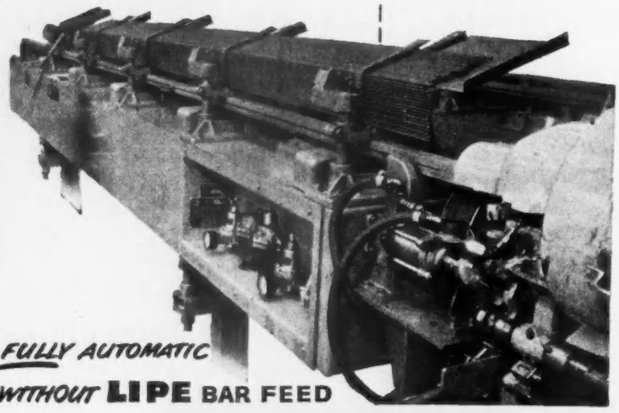
LET US ESTIMATE SAVINGS ON YOUR EXISTING RUN

- Only 4 seconds reloading.
- No idle time, continuous running.
- Proved in use, one operator handles several machines.
- Feeds to last workpiece — without fingers.
- Ejects remnant automatically.
- Range covers 1/8" to 1 1/4" bar, 1/4" to 1 1/4" tube.

AUTOMATIC BAR FEED



THERE'S A LIPE FOR MOST BAR FED MACHINES



* YOUR AUTO IS NOT FULLY AUTOMATIC WITHOUT LIPE BAR FEED

NEW LEAFLET JUST PUBLISHED write Dept. E.2555

Patents Nos. 728898 and 743461 23176/57 and 10916/58.

Automation Ltd.
DEVONSHIRE HOUSE VICARAGE CRESCENT LONDON S W 11
PHONE: BATTERSEA 5549

NRP 2555

PRIEST FURNACES

for non-ferrous metals

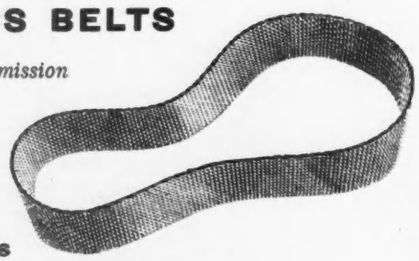
PRIEST FURNACES LIMITED · LONGLANDS · MIDDLESBROUGH

FI31

GRIPOLASTIC

ENDLESS BELTS

for power transmission

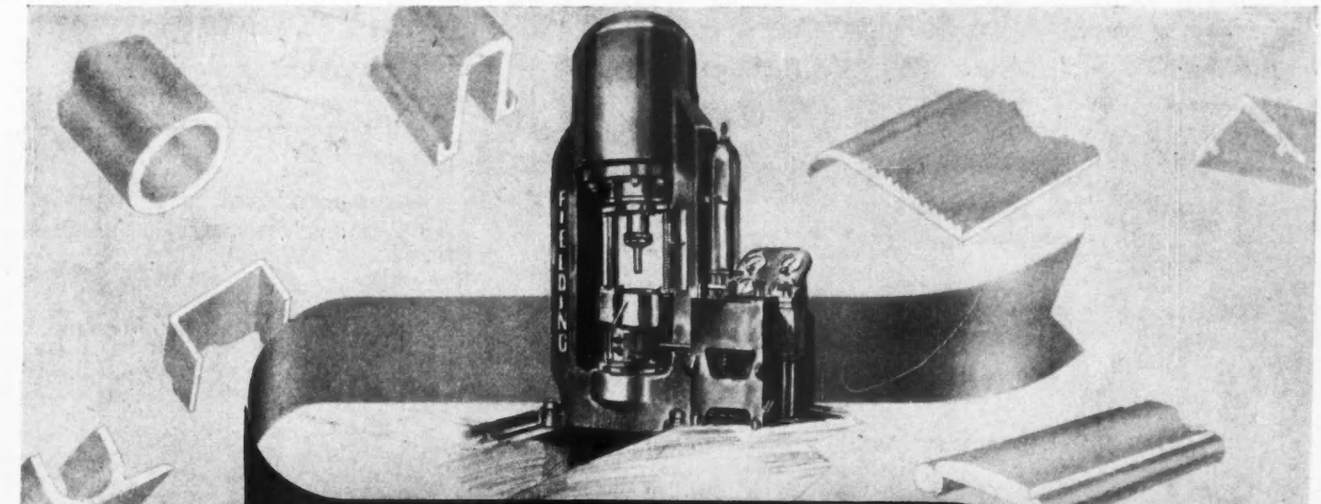


give unequalled performance

ON ALL DRIVES

Sole Manufacturers:

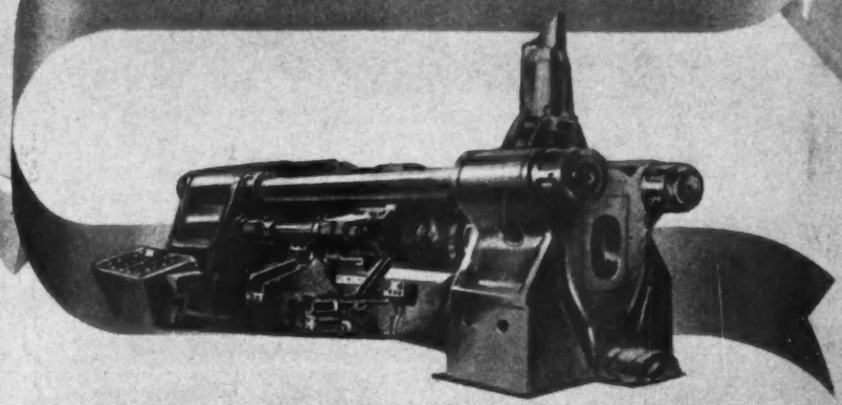
LEWIS & TYLOR LTD
Power Transmission Engineers
GRIPOLY MILLS · CARDIFF Tel: Cardiff 26301
Terminal House, Grosvenor Gardens, LONDON, S.W.1 Tel: Sloane 7883



FIELDING

Vertical & Horizontal

EXTRUSION PRESSES



FIELDING Hydraulic Extrusion Presses, both horizontal and vertical, are designed to extrude a wide range of metals by the direct or inverted method. Presses combining both methods are also available.

Our wide experience in this field enables us to offer equipment of the most modern design, featuring simplicity of design, high productivity, low operating and labour costs, and built to the highest engineering standards.

We also manufacture air hydraulic accumulators, pumps and a wide range of extrusion press ancillary equipment for both new and existing installations.

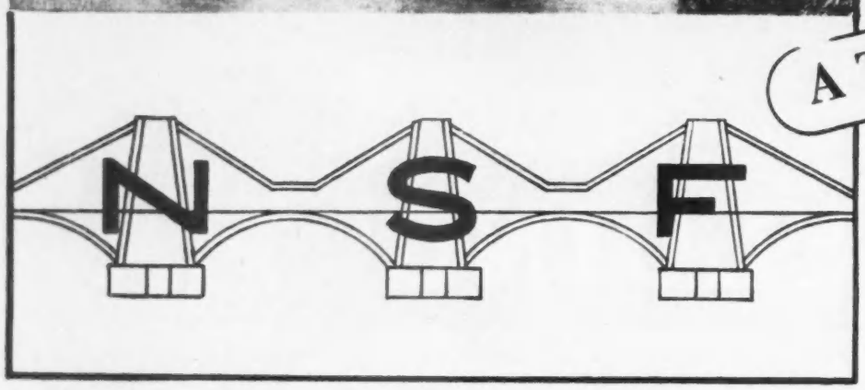
For full information of these and other FIELDING products
please contact our Technical Sales Department

FIELDING & PLATT LIMITED **ENGINEERS, GLOUCESTER, ENGLAND**

K/FP.24

A Landmark

and a monument to courage, skill and achievement.

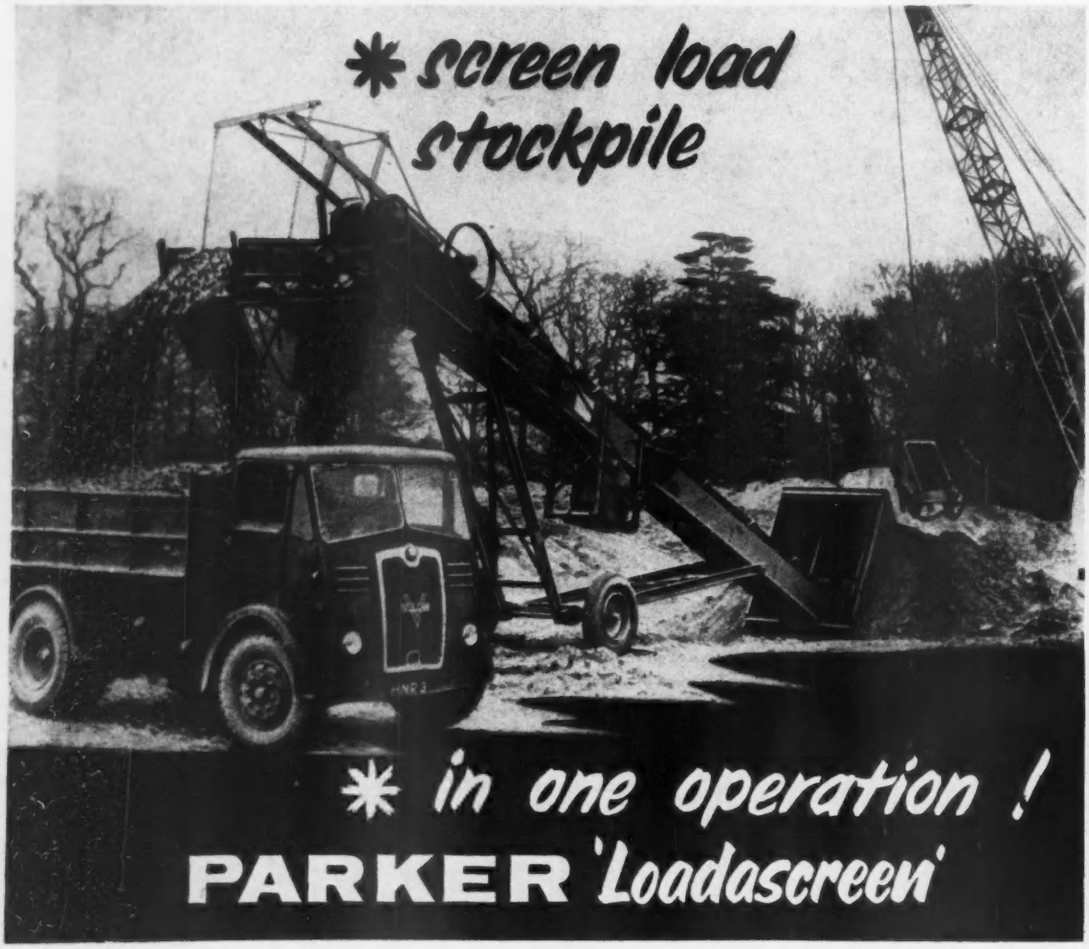


A Trademark

and a guarantee of finish and dependability in steel castings, either black or machined. Over 40 years' experience in producing high grade castings up to 3 tons.
Ample facilities for accurate machining are available if required.

National Steel Foundry

(1914) LTD. KIRKLAND WORKS, LEVEN, FIFE. 'PHONE LEVEN 693. LONDON OFFICE, ALEXANDRA HOUSE, KINGSWAY, W.C.2



Save labour, save double handling—speed up conveying of all bulk materials where screening or scalping off of oversize is required. Handling up to 200 tons an hour, this easily transportable unit screens into 2 or more sizes, gives maximum screening efficiency, can be fed by many methods. With the Parker "Load-a screen" you gain in efficiency, in time, in economy !

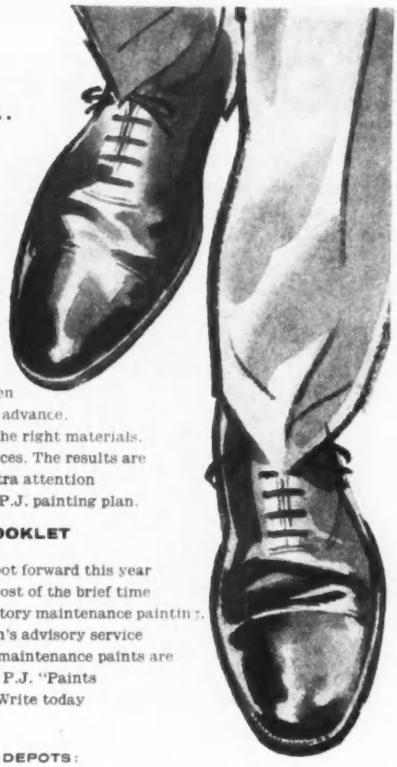
The Parker "Loadascreen" is mounted on pneumatic tyres for towing and easy handling, the screen folding beneath the boom, which can be lowered to a small angle for travelling. Available with boom lengths of 40ft. and 50ft. and belt widths from 18ins. to 36ins. Petrol or diesel engine, or electric motor, is available as power unit. Reciprocating tray feeders are available for all belt widths. A loading trap can be supplied to enclose the feed end, if necessary.

The chain of Parker Service Depots looks after user's interests over the country

FREDERICK PARKER LTD.
VIADUCT WORKS LEICESTER
PHONES: LEICESTER 62531 (7 LINES)
LONDON: STAFFORD HOUSE NORFOLK STREET, W.C.2

WHEN IT COMES TO MAINTENANCE PAINTING...

are you putting your best foot **FORWARD?**



The difference between routine repainting and P.J. *planned* factory maintenance is the difference between defensive operations and a very real advance. The plan is no more than selecting the right materials, texture and colours for the right places. The results are out of all proportion to the little extra attention demanded by the consideration of a P.J. painting plan.

PAINTS FOR BUILDINGS BOOKLET

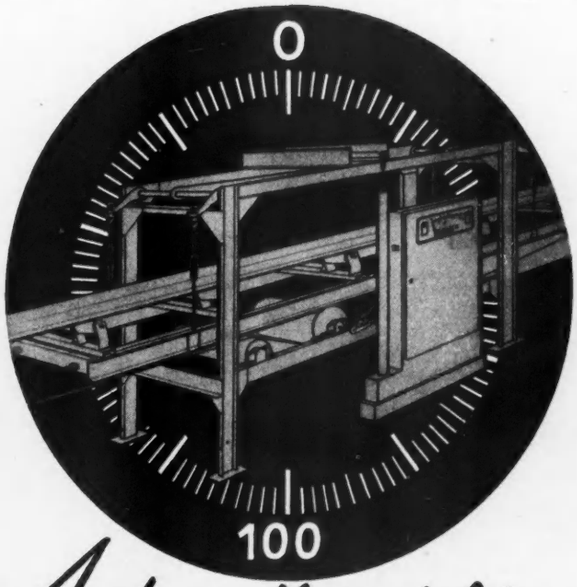
Put your best foot forward this year and make the most of the brief time available for factory maintenance painting. Pinchin Johnson's advisory service and specialised maintenance paints are described in the P.J. "Paints for Buildings". Write today for your copy.

LOCAL BRANCHES AND STOCK DEPOTS:

BELFAST: Dalton Buildings, Dalton St.	Belfast	58643
BIRMINGHAM, 1: King Edward's Place, Broad Street	Midland	1042-3-4
BOOTLE, 20: 72 Brewster Street	Liverpool, Bootle	2121
BRIGHTON, 1: 26-27 Elder Place	Brighton	23739
BRISTOL, 8: 21 High Street, Clifton	Bristol	33889
GLASGOW, C.2: Ocean Chambers, 190 West George Street	Douglas	3281-2
LEEDS, 11: 123 Water Lane	Leeds	24377
MANCHESTER, 3: 22 Bridge Street	Blackfriars	3800
NEWCASTLE-ON-TYNE, 1: Pudding Chare	Newcastle-on-Tyne	21919
SOUTHAMPTON: 41 Lower Canal Walk	Southampton	23648

PINCHIN JOHNSON & CO.

(Building Paints Division) Dept. TE2, 4 CARLTON GARDENS, LONDON S.W.1. Telephone: TRAfalgar 5600



Automatic weighing and conveying

by Automatic Weighing-Machines with electrical load recording. Railway Truck Weighbridges, Road Truck Weighbridges, special designs for industrial requirements and many other types of weighbridges

DÜSSELDORFER WAAGEN- U. MASCHINENFABRIK
ED. SCHMITT & CIE. G. M. B. H.
DÜSSELDORF-GERMANY-P. O. B. 11127

MAAG

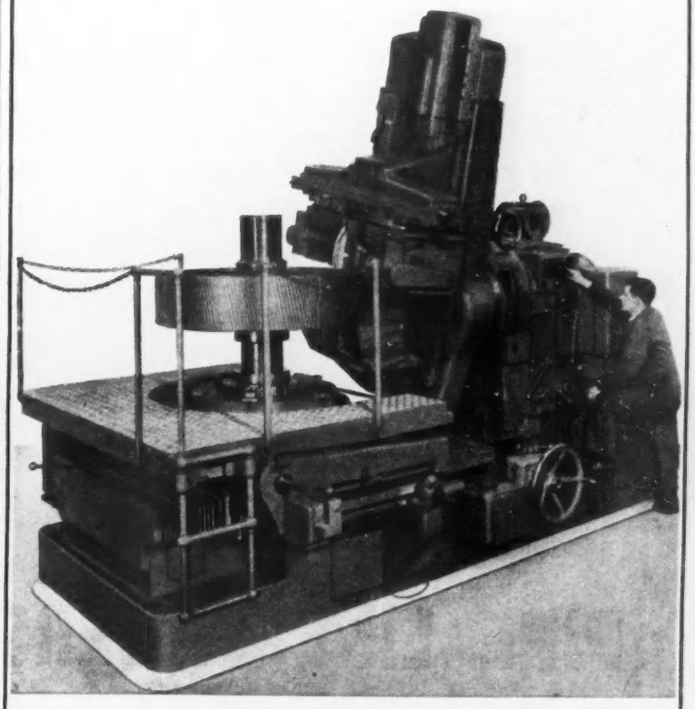
Gear cutting machines

Gear grinding machines

Gear measuring instruments

Gear wheels, speed reduction, speed-increasing and speed-change gears

Precision gear pumps

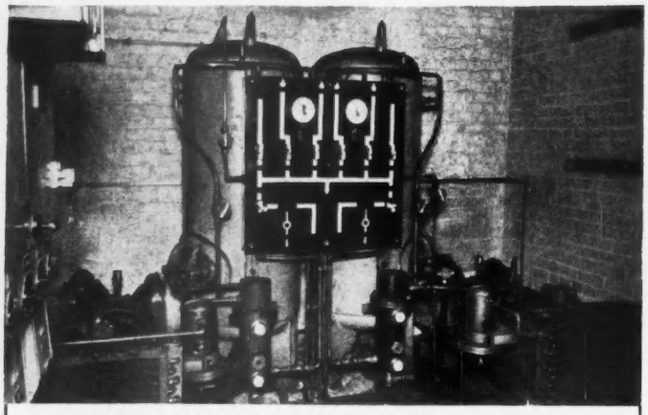


MAAG gear grinding machine, type SHS-150 for spur and helical gears up to 59 in./1500 mm. diameter.

MAAG GEAR-WHEEL CO LTD.

ZURICH (Switzerland)

It's just plain good sense to fit Vokes filters in your air lines

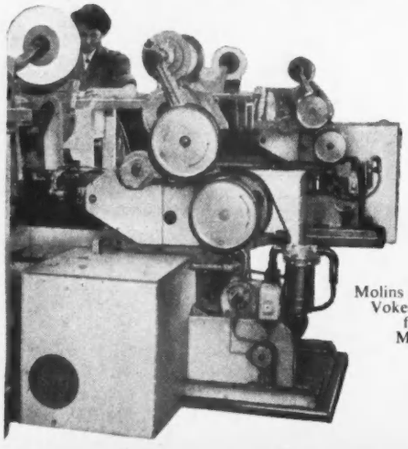


SWITCHGEAR: Vokes C.P.H. filters fitted in an air-operated switchgear room at Kingston power station.

Yes . . . it's good sense to protect air-using plant and machinery against damage, when the protection costs so little. Vokes standard pipe-line filters for instance at strategic points along the line, prevent water, scale and rust from reaching compressed air tools and causing early breakdown and loss of efficiency.

And for special applications, such as in the manufacture and processing of chemicals and food, the packing of cigarettes, there are Vokes pipe-line filters with special silver grey paper elements, excluding not only the "major menaces" but also oil mist and minute particles of foreign matter which present a hazard to the product or the process.

Fit Vokes pipe-line filters—maintain them regularly—and their installation will be repaid a hundred times over.



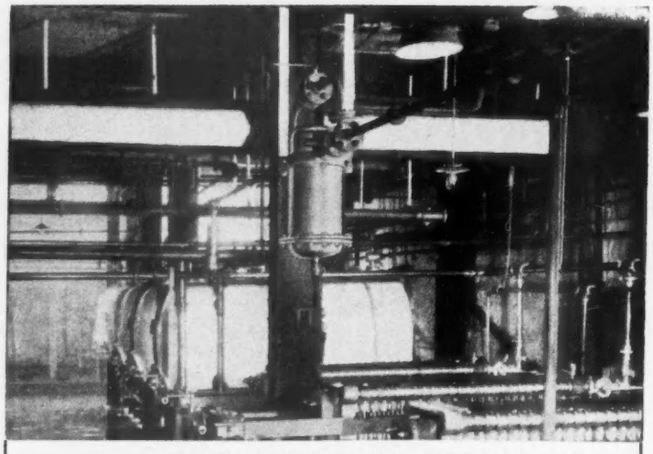
CIGARETTE PACKING

Molins packing machine, showing Vokes Compressed Air Pipeline filter (Photo by courtesy of Messrs. W. D. & H. O. Wills)

VOKES

PIPE LINE FILTERS

Give protection all along the line



BREWERIES: Vokes filters in the airlines of William McEwen & Co. Ltd.'s Edinburgh brewery – ensure that beer is best!

VOKES LIMITED • GUILDFORD • SURREY

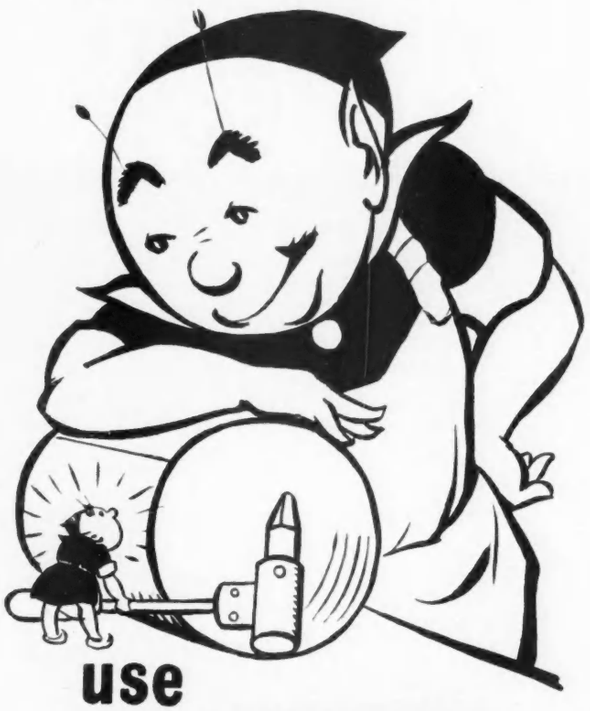
Telephone : Guildford 62861 (6 lines). Grams & Cables : Vokesacess, Guildford, Telex. Telex : 13-535 Vokeacess, Gfd.

Vokes Australia Pty. Ltd., Sydney. *Represented throughout the World.*

VOKES— Air and Gas Filters for Chemical, Nuclear Energy, Oil Refinery, and Pharmaceutical applications etc; Air conditioning filters; Compressed air pipe line filters; Air, Oil and Fuel filters for Diesel, Gas Turbine, and other i/c engines; Hydraulic filters; Silencers for Engines, Fans and Blowers; High efficiency Multi Cyclones.

V334

DON'T LET SOLDERING MAKE YOU FEEL SMALL



use FLUXITE

Soldering ceases to be a knotty problem the moment you use FLUXITE. Solder flows on easily and smoothly—and stays on. For over half a century FLUXITE has been the choice of craftsman and engineer alike and, in this age, its reliability and speed has made FLUXITE even more in demand than ever.

FLUXITE Ltd., Bermondsey St., London, S.E.1

GM 80

"TURBINE" (PATENT) FURNACES

USE

ALL GRADES OF SOLID FUEL EFFICIENTLY

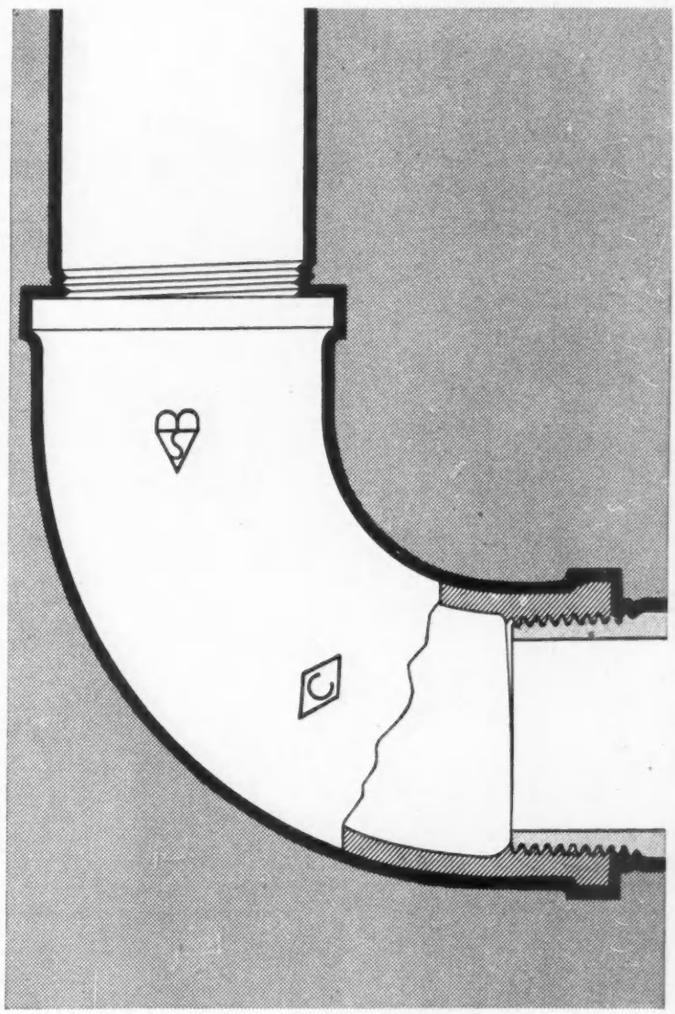
ensuring

LOW STEAM RAISING COSTS

May we investigate without charge?

THE TURBINE FURNACE COMPANY LIMITED

238b Gray's Inn Road, London, W.C.1. 'Phone: TERminus 4365



Why is it easier to make these joints pressure-tight?

Because they are made with the taper threads of Crane Malleable Iron Pipe Fittings. All Crane Pipe Fittings made to British Standard 143 have taper threads, which not only make a more efficient, tighter joint, *but eliminate the need for hemp packing*. Hence, a cleaner finish and better all-round appearance.

Every fitting is tested. Crane Pipe Fittings are highly dependable because they are inspected during manufacture and each one is individually pressure tested at the Crane factory where it is made. They give exceptionally long and trouble-free service.

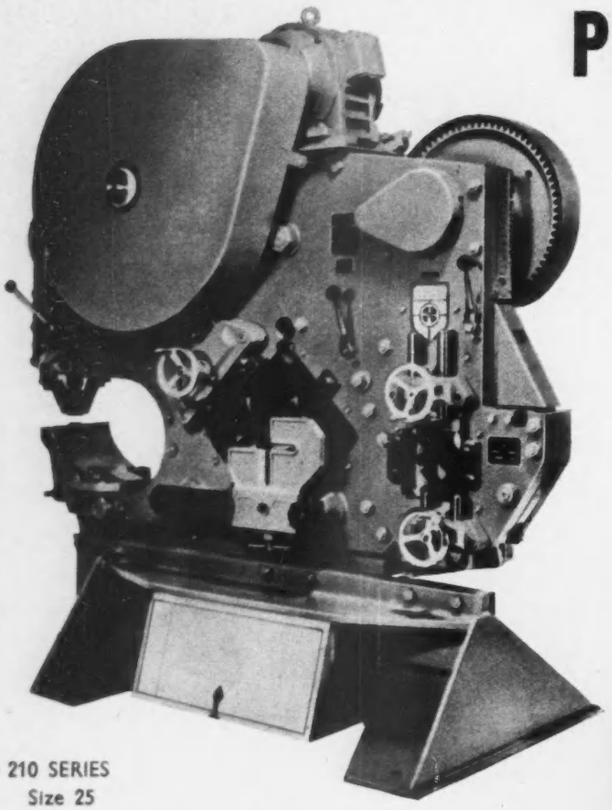
A full versatile range. Crane Pipe Fittings, both plain and banded patterns, are made in many types; they range in size from ⅛-inch to 6-inches, equal and reducing. If you would like full details, please write to us at the address below.

THE TAPER THREAD IS AN OUTSTANDING FEATURE OF

CRANE

MALLEABLE IRON PIPE FITTINGS

Crane Ltd., 15-16 Red Lion Court, Fleet Street, London, E.C. 4
Works: Ipswich. Branches: Birmingham, Brentford, Bristol, Glasgow, London, Manchester



210 SERIES
Size 25

PEDDINGHAUS
UNIVERSAL
STEELWORKER

ORIGINAL PEDDINGHAUS

6 SIZES AVAILABLE

Plate Shearing capacities $\frac{3}{8}$" to 1" M.S.
Angles 3"×3"×$\frac{5}{16}$" to 7"×7"×$\frac{5}{8}$"
Punching $\frac{3}{4}$"×$\frac{1}{2}$" to $1\frac{3}{16}$"×$1\frac{1}{8}$"

NEW FEATURES ARE:

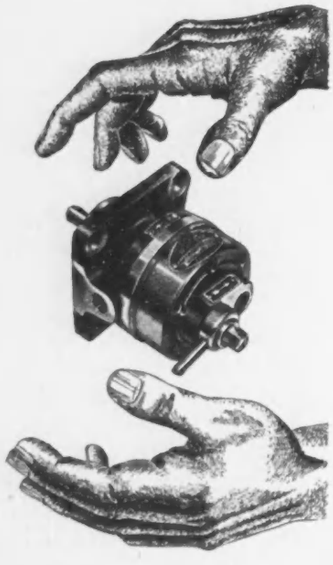
Mechanical Trip combined with length stop
Quick setting holdown for Plate Shear
Visible fine adjustment of guide gibs

Several different models may be inspected in operation at our London Showroom
Immediately opposite North Acton [Central Line] underground station

BIRMINGHAM SHOWROOM
1075 Kingsbury Road, Birmingham, 24 Tel: Castle Bromwich 3781

Exclusive Distributors in the United Kingdom

P&S *The* PRESS & SHEAR *Machinery Co. Ltd*
172-178 VICTORIA ROAD · ACTON · LONDON W3
Telephone: ACOrn 6515/7 Telegrams: PRESACT LONDON TELEX

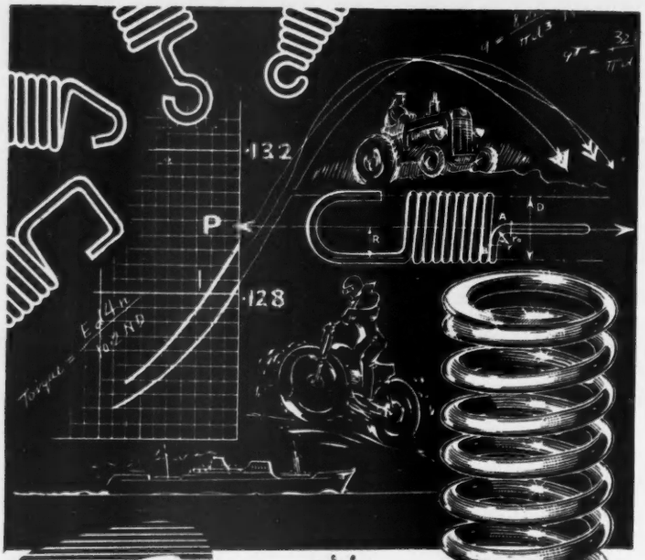


More accurate than human skill itself ----------

Hydraulic Control of motion

Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

FOR FURTHER DETAILS OF
SAVERY HYDRAULIC PUMPS
WRITE TO
THOMAS SAVERY PUMPS LIMITED
BRACEBRIDGE STREET, BIRMINGHAM 6 : Telephone: ASTon Cross 1316-7

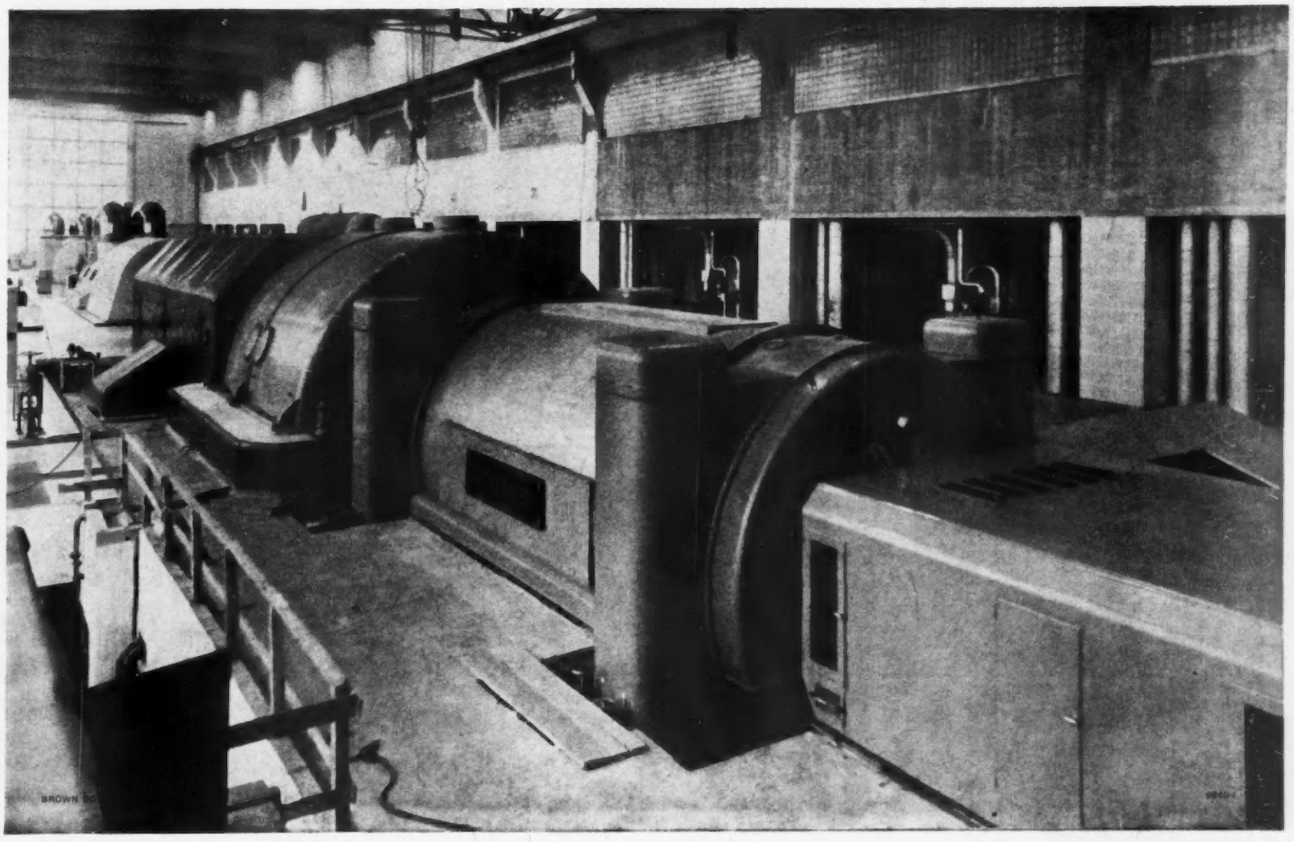


Ratcliffe
SPRINGS

F. S. RATCLIFFE (ROCHDALE) LIMITED,
CRAWFORD SPRING WORKS, NORMAN ROAD, ROCHDALE
'Phone: Rochdale 4692/3. 'Grams: Recoil, Rochdale. CW5188

BROWN BOVERI
STEAM TURBINES

for all ratings, pressures, and temperatures



One of five Brown Boveri 150-MW turbine-generator sets with 214-MVA turbo-generator in a large power station of an interconnected system

The Company plans and builds complete power stations

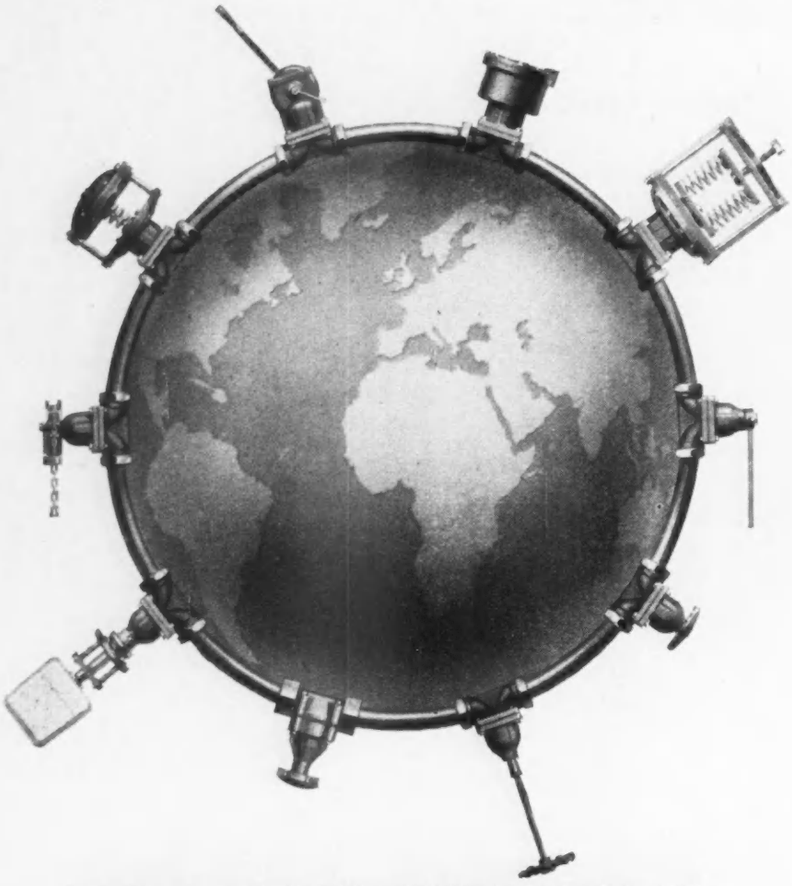
Some other manufactures :

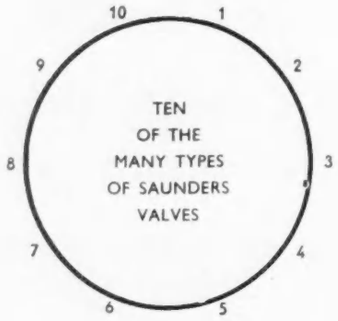
Complete steam, gas turbine, and nuclear power stations; electrical equipment for hydro-electric and diesel power stations; electric furnaces, electric welders; transmitting and rectifier tubes, radio transmitters; electric traction equipment; marine drives; turbo-compressors

BROWN BOVERI

BROWN, BOVERI & CO., LTD.
BADEN (SWITZERLAND)

Representatives in most countries





1 Piston Operated
½"—14"

2 Diaphragm Operated
Pressure Opening
½"—6"

3 Lever Operated
Quick Action (90°)
½"—1¼"

4 Handwheel Operated
¼"—14"

5 Extended Spindle
½"—14"

6 Plastics Valves
½"—2"

7 Electrically Operated
½"—14"

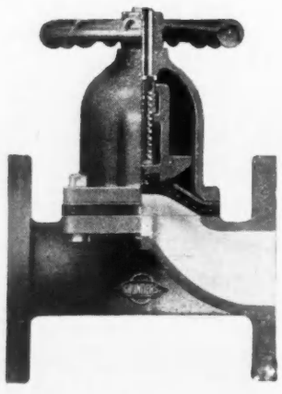
8 Chainwheel Operated
1½"—14"

9 Diaphragm Operated
Pressure Closing
½"—8"

10 Lever Operated
Quick Action with
Positional Lock
1½"—4"

SAUNDERS DIAPHRAGM VALVES

Millions in use around the world for handling fluids as simple as air and water, as delicate as food and medicines and as difficult as corrosives and abrasives



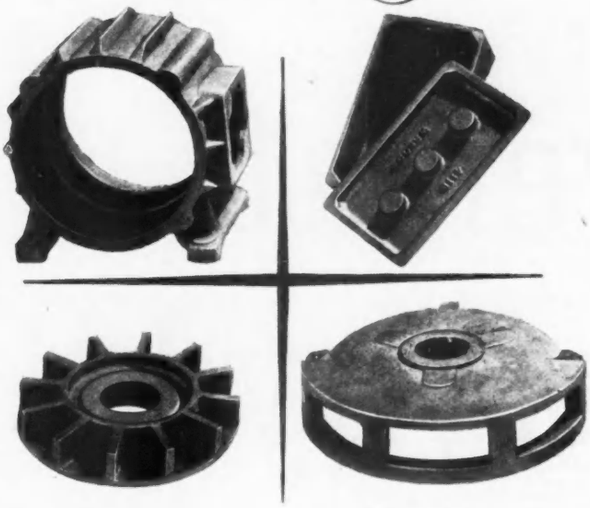
SAUNDERS VALVE COMPANY LIMITED

DIAPHRAGM VALVE DIVISION

CWMBRAN NEWPORT MONMOUTHSHIRE

MACHINE MOULDED REPETITION

Castings...



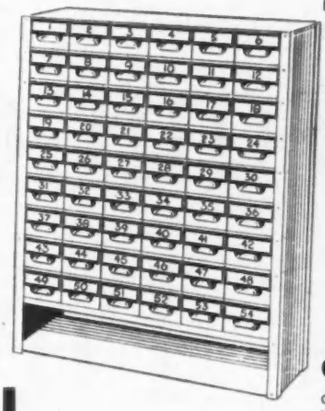
IN GREY IRON, GUN METAL, HIGH TENSILE BRASSES AND ALUMINIUM

from print to product!

THOS. HOLCROFT

AND SONS LIMITED

ETTINGSHALL FOUNDRY, WOLVERHAMPTON TELEPHONE: WOLVERHAMPTON 41271/2



IMMEDIATE DELIVERY FROM STOCK

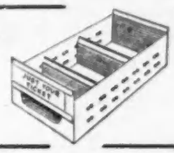
54 DRAWER ALL STEEL UNIT

£18 DELIVERED FREE

Overall size 42" High by 36" Wide by 12" Deep, an ideal storage unit, built for a lifetime's service. Each drawer contains one FREE Divider. Extra Dividers 6d. each. 54 Cards FREE.

Each DRAWER in above unit 5" Wide, 3" High, 11¼" Long

Send for SAMPLE DRAWER without obligation.



★ *Two examples from the very wide range of low-priced storage equipment manufactured by:*

N. C. BROWN Ltd.,

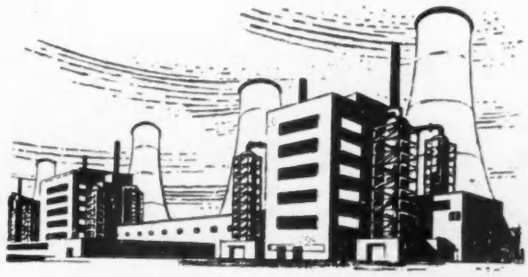
GREEN LANE STEEL WORKS, HEYWOOD, LANCASHIRE.

Tel. 69018/9

We are proud to have been entrusted with large contracts for the thermal insulation of

CHAPELCROSS

NUCLEAR POWER STATION



OVER 300,000 SQUARE FEET OF INSULATED SURFACES

Throughout the years Newalls have built an enviable reputation in the insulation of conventional power stations. This specialised experience is now being drawn upon on an ever growing scale in solving the complex insulation problems in Nuclear Power Development.

At CHAPELCROSS—U.K.A.E.A. NUCLEAR POWER STATION for example; under contract to Babcock & Wilcox Ltd., Newalls are carrying out the insulation of the 16 steam raising units and integral piping. The insulation of turbines, blowers, associated auxiliary equipment and piping is being carried out under contract to C. A. Parsons & Co. Ltd.

The principal insulants employed are Newalls own products 85% MAGNESIA and NEWTEMPHEIT and all the application work is being carried out by the Newalls contractual organisation. The latest addition to the Newalls range NEWTHERM Calcium Silicate Insulation has also been applied for the first time on a nuclear power station.

Today's projects (like Chapelcross) need

Newalls INSULATION

NEWALLS INSULATION CO. LIMITED

Head Office: WASHINGTON, CO. DURHAM

A member of the TURNER & NEWALL ORGANISATION

Offices and Depots at LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF. *Agents and Vendors in most markets abroad.*

Atomic Power at Trawsfynydd

The Contract for the Atomic Power Station to be built at Trawsfynydd in North Wales has been awarded by the Central Electricity Generating Board to

Atomic Power Constructions Limited

This latest Atomic Station will feed into the national grid 500,000 kilowatts of electricity.

The whole of the generating plant for Trawsfynydd, comprising the steam turbo-alternators with the condensing plant and feed-heating systems, and the blowers to circulate the hot gas through the reactors, will be built by

Richardsons, Westgarth & Co. Ltd.

A MEMBER OF ATOMIC POWER CONSTRUCTIONS LIMITED

MEMBER COMPANIES OF ATOMIC POWER CONSTRUCTIONS LIMITED

Crompton Parkinson Ltd. International Combustion (Holdings) Ltd.
Fairey Aviation Limited Richardsons, Westgarth & Co. Ltd.

ASSOCIATES:— Nuclear Civil Constructors.
(Trollope & Colls Ltd. and Holland & Hannen and Cubitts Ltd.)

THE RICHARDSONS WESTGARTH GROUP

WALLSEND · SUNDERLAND · HARTLEPOOL · IMMINGHAM AND LONDON

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g. ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

GOVERNMENT OF WESTERN NIGERIA

VACANCY FOR PRINCIPAL TECHNICAL INSTITUTE

Applications are invited from suitable candidates for the post of PRINCIPAL, TECHNICAL INSTITUTE.

Qualifications: Candidates must be a Graduate in Engineering or have an equivalent qualification. Desirable that he should be a Corporate Member of one of the professional Engineering Institutions. Experience in industry, and good teaching and administrative experience in a Technical College are essential.

Duties: To administer, organise and assist in the establishment (including the equipment of laboratories, workshops, &c.) of a new Technical Institute. The Institute will be non-residential, providing sub-professional courses in Mechanical, Civil and Electrical Engineering, Building and Commerce during the early years of its establishment. It is proposed to make provision for Domestic Science and other Technologies, such as printing, in the later development of the Institution.

Terms of Appointment: On contract terms for a minimum of two tours of 12–18 months each in the first instance. Salary is £2448 consolidated. Gratuity at the rate of £37 10s. for each completed three months' service. Free first-class passages for officer and his family on first appointment and when proceeding on leave; free medical treatment for officer and his family. Accommodation is provided at low rentals.

Applications should be completed in duplicate on the prescribed form, obtainable from the Official Secretary (Recruitment Branch), Office of the Commissioner for Western Nigeria, 178/202, Great Portland Street, London, W.1, from whom further particulars may also be obtained.

Closing date: 26th June, 1959. E6731

DERBY AND DISTRICT COLLEGE OF TECHNOLOGY

Principal: T. HEAP, Ph.D., M.Sc., F.R.I.C., A.M.I.I.A.

APPOINTMENTS

Applications are invited for the following posts, duties to commence in September, 1959, or as soon as possible thereafter:

LECTURER in MECHANICAL ENGINEERING to teach subjects for O.N.C., H.N.C., Higher Diploma and London B.Sc. courses in Mechanical or Production Engineering. Applicants should have a degree or equivalent and good industrial and teaching experience.

ASSISTANT GRADE "A" or GRADE "B" according to qualifications and experience to teach the subjects of science and technique to students in various trade courses including Machine Shop Engineering, Foundry, Steel Fabrication and Motor Vehicle Service. Applicants should have good industrial experience and appropriate academic qualifications.

Salaries in accordance with Burnham Further Education Scales as follows:

Assistant Grade "A," £498 15s. by £26 5s. to £945.

Assistant, Grade "B," £682 10s. by £26 5s. to £1076 5s.

Lecturer, £1260 by £31 10s. to £1417 10s.

In scales to Assistants, Grade "A" and "B" allowances are payable for degree and training and up to 12 increments for approved industrial experience.

Application forms and further particulars can be obtained from the Principal, Derby and District College of Technology, Normanton Road, Derby, by whom completed applications should be received within two weeks of the appearance of this advertisement.

C. MIDDLETON,
E6700 Secretary to the Joint Committee.

ROYAL TECHNICAL COLLEGE, SALFORD

DEPARTMENT OF ELECTRICAL ENGINEERING

LECTURERS

Applications are invited for the following posts in the Department of Electrical Engineering.

(a) SENIOR LECTURER. Salary £1417 10s. by £52 10s. to £1627 10s. (men).

(b) LECTURER. Salary £1260 by £31 10s. to £1417 10s. (men).

Successful applicants may be placed at intermediate points in these scales in accordance with previous experience in an equivalent capacity and/or industrial experience.

These vacancies offer an exceptional opportunity for those who wish to participate at the early stages in the current new developments in engineering education. Those appointed will be expected to lecture undergraduate courses, and post-graduate courses where appropriate. The greatest importance is attached to the undertaking of original research work of high quality, as an integral part of the work of the staff; time is allowed for this. In consequence, proven research ability is a strong recommendation for these appointments, and considerable weight will be placed upon this factor. For a candidate strongly qualified in this way, previous lecturing experience will be of secondary importance.

Further particulars and forms of application may be obtained from the Registrar, Royal Technical College, Salford, 5, Lancs, to whom completed applications should be returned as soon as possible.

R. RIBBLESDALE THORNTON,
E6091 Clerk to the Governors.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF
LECTURERS OR ASSISTANT LECTURERS IN MECHANICAL ENGINEERING

The Governing Body invites applications for LECTURESHIPS or ASSISTANT LECTURESHIPS IN MECHANICAL ENGINEERING in The Manchester College of Science and Technology, with corresponding title and status in the University of Manchester.

The Department covers a very wide field in Mechanical Engineering, including Photoelasticity, Fatigue, Servo-Mechanisms, Vibrations, Machine Tools and Production Processes and Heat Transfer. A special high-level Diploma Course in Machine Tool Design, lasting two years, has just been inaugurated. All members of staff are expected to undertake, assist in or supervise research in their particular subject, for which facilities are excellent. The teaching is almost entirely confined to Graduate and Post-Graduate Courses for Internal Degrees and Diplomas. Short courses for specialists in subjects of particular interest are offered each year.

Salary: Lecturer, £900 by £50 to £1350 by £75 to £1650; Assistant Lecturer, £700 by £50 to £850.

Commencing salary according to qualifications and experience. F.S.S.U. and family allowances.

Conditions of appointment and form of application may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1. The last day for the receipt of applications is Tuesday, 30th June, 1959. E6092

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

SENIOR LECTURER AND LECTURER

Applications are invited for the positions of SENIOR LECTURER and LECTURER IN PRODUCTION ENGINEERING in the Department of Industrial Engineering. Applicants should possess good academic qualifications and have had industrial and, preferably, teaching experience in the fields of at least two of: Theory of Machine Tools, Metrology and Engineering Production Technology. Experience in Tool Design would also be an advantage.

Commencing salary will be determined by previous experience and qualifications, according to the scales:

Senior Lecturer: £1417 10s. by £52 10s. to £1627 10s.

Lecturer: £1260 by £31 10s. to £1417 10s.

The posts are pensionable.

Application forms and further particulars may be obtained from the Registrar. (In reply, please quote 9/C.) E6737

UNIVERSITY OF MANCHESTER

LECTURER IN ENGINEERING (NUCLEAR)

Applications are invited for the post of LECTURER IN ENGINEERING (NUCLEAR). Candidates should be graduates in engineering or physics: experience of experimental reactor physics or heat transfer would be an advantage. The successful candidate will take part in teaching and research work in the Nuclear Engineering Laboratory. University regulations permit teaching staff to read for the degrees of M.Sc. and Ph.D. Applications will also be considered from engineers and physicists who would be interested in a temporary appointment of two or more years. The salary scale is £900 to £1650 per annum. Membership of the F.S.S.U. and Children's Allowance Scheme. Initial salary according to qualifications and experience. Applications should be sent not later than July 18th, 1959, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained. Applications by airmail (no forms) will be considered from overseas candidates. E6755

WEST MIDLANDS GAS BOARD

WOLVERHAMPTON AND DISTRICT DIVISION

DIVISIONAL DRAWING-OFFICE

CHIEF DRAUGHTSMAN

Applications are invited from suitably qualified persons for the above post.

Candidates must have knowledge of the design and construction of gas works plant and foundations, be experienced in the preparation of large schemes and specifications, and should preferably have been in control of a Drawing-Office.

The successful candidate will be responsible to the Divisional Engineer for the preparation of schemes relating to all new plant and modifications to existing plant throughout the Division, and will also be concerned with the installation and the erection of all new plant.

The salary for the appointment, which is pensionable and subject to medical examination, will be within A.P.T. Grade 12 (£1006–£1131 per annum) of the National Salary Scales for Gas Staffs.

A house or bungalow may be available if required.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to Mr. Stanley Jones, Divisional General Manager, West Midlands Gas Board, Kensington House, Bath Street, Dudley.

J. SWAN,
E6714 Secretary to the Board.

SOUTH AUSTRALIAN RAILWAYS

ASSISTANT ENGINEERS

Applications are invited from Engineers with at least three years' field experience on permanent way maintenance or construction including survey and setting out.

Minimum qualification is Higher National Certificate but preference given to applicants possessing qualifications acceptable for membership of the Institution of Civil Engineers or Permanent Way Institute.

Commencing salary from £A1065 to £A1185 per annum. Progression to £A1425 assured to applicant with appropriate qualifications.

First class family passages paid and assistance with housing given.

Applications to: Agent General for South Australia, South Australia House, Marble Arch, London, W.1. E6742

ROYAL MINT

MECHANICAL ENGINEER

Royal Mint has vacancy for a MECHANICAL ENGINEER. Pensionable post. Qualifications: preferably Honours Degree in mechanical engineering with metallurgical knowledge and 2 years' practical experience.

Apply in writing for particulars to Establishment Officer, Royal Mint, London, E.C.3. E6096

REPUBLIC OF THE SUDAN

MINISTRY OF AGRICULTURE, SUDAN

APPOINTMENTS

Applications are invited from those suitably qualified to fill the following vacancies in the Ministry of Agriculture, Sudan:—

(a) AGRICULTURAL ENGINEERS (reference 4/405).

(b) MECHANICAL ENGINEERS (reference 4/430).

(c) AGRICULTURAL ENGINEERING RESEARCH OFFICERS (reference 4.405).

Candidates for Post (a) should hold a B.Sc. Degree or its equivalent, and have had previous practical experience. Age 23–45 years.

Post (b), A.M.I.Mech.E., or a Degree exempting them from Parts A and B of the examination, and have served a recognised apprenticeship and have sound knowledge of general mechanical engineering construction, operation and maintenance. A knowledge of cotton ginning would also be an advantage. Age 35–45 years.

Post (c), qualifications as in (a) above. Age 23–45 years.

Candidates must be fully literate in Arabic or English. Appointment will be on contract for a period of up to five years, in the salary range £S.1075–£S.1675, with bonus, or £S.1146–£S.1786, without bonus. Commencing salary will be determined according to age, qualifications and experience. A variable cost-of-living allowance is payable and an initial outfit grant of £S.50 on appointment. Annual leave accrues at the rate of 7 days per month.—For further information and application forms write to Sudan Embassy, Personnel Section, Cleveland Row, St. James's, London, S.W.1, quoting the appropriate reference. Closing date June 30, 1959. E6087

GOVERNMENT OF QATAR—PERSIAN GULF

ASSISTANT DESIGN ENGINEER

The Government of Qatar, in the Persian Gulf, invites applications from Graduate Civil Engineers seeking practical design experience, for the post of ASSISTANT DESIGN ENGINEER in the State Engineer's Office.

Applicants must have passed or be exempted from taking Parts A and B of the Associate Membership Examination of the Institution of Civil Engineers.

Work includes the structural design of buildings and general civil engineering designs connected with a rapidly developing town of about 30,000 people.

SALARY: Starting at Rupees 1775 per Arabic month (equivalent to £1598 per annum), with annual increments of Rs.75/- a month to a maximum of Rs.1925 per Arabic month. A three-year contract is offered subject to six months' probationary period. Gratuity payable on completion of contract. Leave six days for each month of duty. Free passages, accommodation, fuel, light and water. No income tax.

APPLICATIONS, endorsed "Assistant Design Engineer," should be sent in duplicate to: C. Tennant Sons and Co., Ltd., 4, Copthall Avenue, London, E.C.2, giving full details of training, &c., age, nationality, religion, marital status, the names of three referees and a recent dated photograph. E6093

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

SENIOR SCIENTIFIC OFFICERS (a): SCIENTIFIC OFFICERS (b).—Pensionable posts for men or women in all major scientific fields, including physics, chemistry, mineralogy, biology, forensic science, meteorology and mathematics.

Age limits: (a) at least 26 and under 31; (b) at least 21 and under 28.

Extension for regular Forces Service and Overseas Civil Service.

Qualifications: normally First or Second-class Honours Degree in Science, Mathematics or Engineering, or equivalent attainment; additionally, for (a), at least 3 years' relevant (e.g. post-graduate) experience. London salaries (men): (a) £1233–£1460; (b) £655–£1150; provision for starting pay above minimum. Promotion prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting (a): S53/59; (b) S52/59. E6733

Classified Advts. continued on page 68

PUBLIC APPOINTMENTS

CITY OF LEEDS

WATERWORKS DEPARTMENT

APPOINTMENT OF STAFF

Applications are invited for the following appointments :

(a) ENGINEERING ASSISTANT (APT. IV), £1065–£1220.

(b) ENGINEERING ASSISTANTS (3 posts) (APT III), £880–£1065.

(c) DRAUGHTSMAN (HGD), According to age—Maximum £595.

Applicants for post (a) must be Corporate members of the Institution of Civil Engineers. Experience in the design and construction of reinforced concrete water retaining structures and/or Impounding Reservoir Schemes will be an advantage.

Applicants for posts (b) should be Graduates of the Institution of Civil Engineers or have a University Degree or equivalent qualification. Experience with a Water Undertaking will be an advantage. For one of the posts experience in the design and installation of pumping plants is desirable.

Applicants for post (c) should be neat draughtsmen and experience in Civil Engineering drawings will be an advantage.

Superannuation payable. Medical examination.

Applications should be delivered not later than 12 noon on Thursday, 2nd July, 1959, endorsed with the description of the post applied for.

Canvassing disqualifies.

KENNETH L. FORSTER,
General Manager and Engineer.

Waterworks Department,
Civic Hall,
Leeds, 1.
12th June, 1959. E6748

CROWN AGENTS FOR OVERSEA GOVERNMENTS AND ADMINISTRATIONS

ASSISTANT ENGINEER (MECHANICAL)

ASSISTANT ENGINEER (MECHANICAL) required for their London Office by the Crown Agents for Oversea Governments and Administrations for appointment to pensionable establishment on probation for 2 years. Commencing salary between £830 at age 25 and £1125 at age 34 or over in scale rising to £1300. Fully qualified Officers at least 27 years of age may be eligible for special increase of £75 after 2 years' service. Liberal leave. 5-day week. Candidates must hold degree in Mechanical Engineering and/or be Corporate or Graduate Members of the Institution of Mechanical Engineers and have served a recognised apprenticeship or pupilage to mechanical engineering with subsequent industrial experience. Previous experience of contracts work and a knowledge of refrigerating plant, printing machinery or industrial chemical plant an advantage. Duties include the purchase of all types of mechanical industrial equipment, adjudication upon tenders and advice to overseas administrations on problems connected with the above equipment. Write to the Crown Agents, 4, Millbank, London, S.W.1, state age, name in block letters, full qualifications and experience and quote M2A/50636/EH. E6744

COUNTY BOROUGH OF NEWPORT WATER DEPARTMENT

APPOINTMENTS

Applications are invited from suitable candidates for the following appointments :

(a) SENIOR ASSISTANT ENGINEER, Grade A.P.T. IV, £1065–£1220 per annum.

(b) ASSISTANT ENGINEER, Special Grade, £785–£1070 per annum.

(c) ENGINEERING DRAUGHTSMAN, Misc. Grade V, £650–£715 per annum.

Incremental position according to experience.

Applicants for (a) and (b) must be Corporate Members of the Institution of Civil Engineers and preference will be given to those experienced in the design and construction of large Aqueducts, Purification Works, Reinforced Concrete Work. The Department has in hand an extensive programme of very large Capital Works for Industrial and Domestic Supplies.

Applicants for (c) should preferably hold a National Certificate and be a neat and experienced draughtsman.

The posts are superannuable and housing accommodation is available if required.

Applications, stating age, education, training, professional qualifications and experience, with names of two referees, should be sent to the Water Engineer and Manager, Royal Chambers, High Street, Newport, Mon., not later than 30th June, 1959. E6708

MINISTRY OF SUPPLY

CHESSINGTON, SURREY

TECHNICIANS

Ministry of Supply require TECHNICIANS at Chessington, Surrey, for the preparation of technical publications on guided weapons, radar and electronic equipment.

Qualifications : Recognised engineering apprenticeship or equivalent training in appropriate trade. Experience in guided weapons or radar and electronic equipment is essential. Previous experience of writing or editing technical publications, and possession of O.N.C., C. and G. Final Certificates, or equivalent qualification desirable.

Rate of Pay : £900 (age 30) to £1065 per annum.

Application forms from M.O.L. and N.S., Professional and Executive Register (P.E.1351), Atlantic House, Farringdon Street, London, E.C.4. E6715

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Vacancies for SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in following localities :

LONDON AREA : MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles ; knowledge of theoretical hydrodynamics and theory of control systems an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICISTS for acoustic analysis. ELECTRONIC PHYSICISTS for data handling and analysis problems. PHYSICIST interested in operator performance. CLASSICAL PHYSICISTS.

BALDOCK : PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH : ELECTRONIC ENGINEERS for research on analogue computers and transistor circuits. ELECTRICAL ENGINEERS for research on small rotating electrical machinery. PHYSICISTS—for optical systems and instrumentation. ELECTRO-MECHANICAL ENGINEERS—for work on servo-mechanisms.

PORTLAND : PHYSICISTS or APPLIED MATHEMATICIANS for research on underwater acoustics. ELECTRONIC PHYSICISTS, ELECTRONIC ENGINEERS—for design work. PHYSICAL CHEMISTS.

POOLE : CHEMICAL ENGINEERS. CHEMISTS for work on rubber technology.

ROSYTH : PHYSICISTS (Electronic).

Candidates must normally be natural born British subjects of natural born British parents, with First or Second-Class Hons. Degrees. S.S.O.s must have had three years' post-graduate experience and be not less than 26 years of age. Salaries : (men) S.S.O., £1233–£1460 ; S.O., £655–£1150 (London), somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.220/9A). E5866

FRIERN GROUP HOSPITAL MANAGEMENT COMMITTEE

FRIERN HOSPITAL (FOR NERVOUS AND MENTAL DISORDERS)

NEW SOUTHGATE, LONDON, N.11.

SENIOR ENGINEER

Applications are invited for the post of SENIOR ENGINEER at the above Hospital, under the direction of the Superintendent Engineer. Salary in the scale £770–£915 per annum, plus London Weighting. The appointment is subject to National Health Service (Superannuation) Regulations, 1950. The successful candidate will be required to pass satisfactorily a medical examination and will be required to act as a deputy to the Superintendent Engineer covering all the hospitals in the Group.

Candidates must have served a recognised Apprenticeship in Mechanical Engineering or have otherwise acquired a thorough practical mechanical engineering training as distinct from purely craft training. They must have a sound knowledge of the principles and practice of the efficient operation of Steam Boiler Plants, to have had a wide experience in a supervisory position of such types of Mechanical and Electrical Engineering services as are found in large institutions and as are appropriate to the post and hold one of the following qualifications : Ministry of Transport and Civil Aviation (ex Board of Trade) ; First Class Certificate of Competency in Marine Engineering or equivalent Naval Certificate ; City and Guilds Full Technological Certificate in Plant Engineering (First Class).

No resident accommodation is provided but the successful candidate will be required to live within a reasonable distance of the Hospital.

Applications, stating age, education, professional training, qualifications and experience, accompanied by two copies only of recent testimonials, and the names and addresses of two professional referees, to reach the Group Secretary at the Management Committees Offices at Friern Hospital, Friern Barnet Road, New Southgate, London, N.11, not later than 9 a.m. Monday, 29th June, 1959. E6729

TRINITY HOUSE, LONDON

ASSISTANT WORKSHOPS SUPERINTENDENT

Applications are invited for the post of ASSISTANT WORKSHOPS SUPERINTENDENT, at the Workshops of the Corporation of Trinity House situated at Blackwall, E.14.

Candidates should be of British Nationality and between the ages of 32 and 42 years.

Applicants should have served a proper indentured apprenticeship and be either graduate or associate members of the Institution of Mechanical or Electrical Engineers. Practical experience in Workshop processes and management and the repair and maintenance of internal combustion engines, plant and equipment is essential. The possession of a 1st Class Engineers Ministry of Transport certificate would be an advantage.

The appointment is permanent and pensionable and subject to one year's probation. Salary £970 by various annual increments to £1440 per annum maximum.

Applications in writing to the Secretary, Trinity House, Tower Hill, London, E.C.3, by 30th June, 1959, stating age, qualifications, experience and enclosing copies of references. E6724

PUBLIC APPOINTMENTS

SOUTHERN RHODESIA GOVERNMENT

CENTRAL MECHANICAL EQUIPMENT DEPARTMENT

VACANCY : MECHANICAL ENGINEER

Applications are invited for the post of MECHANICAL ENGINEER in the Central Mechanical Equipment Department.

Applicants must be Associate Members of the Institution of Mechanical Engineers, have had sound mechanical engineering experience connected with the repair of vehicles and construction equipment. In addition, applicants should have had experience of :

(a) Man management and management control.

(b) Labour control systems.

(c) Methods engineering, time and motion study and job analysis.

Salary scale : £1925 by £75 to £2000 by £50 to £2050.

Application forms and further details from the Secretary (R), Rhodesia House, 429, Strand, London, W.C.2. E6704

MINISTRY OF SUPPLY

BLACKBURN, LANCS.

TECHNICIAN

Ministry of Supply require TECHNICIAN at Blackburn, Lancs., to supervise skilled and semi-skilled staff engaged on inspection of components and assemblies for clockwork mechanisms.

Qualifications : Recognised engineering apprenticeship. Experience of inspection of small precision components and sound knowledge of clockwork mechanisms. Possession of O.N.C. in Mechanical Engineering, appropriate C. and G. Final Certificates, or equivalent qualification desirable.

Salary : £850 (age 30) to £1005 per annum.

Application forms from Manager (P.E.1350), Ministry of Labour and National Service, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E6716

BOARD OF GOVERNORS HAMMERSMITH AND ST. MARK'S HOSPITALS

DU CANE ROAD, LONDON, W.12

ENGINEERING TECHNICAL ASSISTANT

ENGINEERING TECHNICAL ASSISTANT required. Salary scale (under review), £725 by £20 (4) by £25 (2) to £855, plus London Allowance, £20–£40.

Further particulars from Secretary. E6738

TENDERS

SCOTTISH HOME DEPARTMENT

GRETNA–STRANRAER–GLASGOW–STIRLING TRUNK ROAD A.77 RECONSTRUCTION OF KILMARNOCK ROAD BETWEEN WOODVALE AVENUE AND MALLETSHEUGH INN

The Secretary of State invites TENDERS for the above scheme, which involves the widening and reconstruction to a dual carriageway layout of approximately 2·7 miles of the above road.

Drawings of the proposed works will be available for inspection as from 30th June, 1959, at the offices of the Consulting Engineers, Messrs. Kyle and Frew, 9, Clairmont Gardens, Glasgow, C.3.

Contract Documents are obtainable from the Consulting Engineers at the above address upon payment of a deposit of £15 by cheque or draft made payable to order of the Queen's and Lord Treasurer's Remembrancer. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders on the official form which must be received before 4 p.m. on Monday, 17th August, 1959, should be sent in a sealed registered envelope marked "Tender for Kilmarnock Road," addressed to the Secretary, Scottish Home Department, Broomhouse Drive, Saughton, Edinburgh, 11.

The Secretary of State does not bind himself to accept the lowest or any tender. E6746

WOKING URBAN DISTRICT COUNCIL

MAIN DRAINAGE—CONTRACT NO. 6

TO MANUFACTURERS OF CENTRIFUGAL PUMPING PLANT

TENDERS invited for MANUFACTURE, SUPPLY and ERECTION of 15 SETS VERTICAL UNCHOKABLE SEWAGE PUMPS, 3 SETS VERTICAL SUSPENDED SUMP TYPE RECIRCULATION PUMPS, and 3 VERTICAL DISINTEGRATORS. Duties range from 100–2000 gallons per minute against total heads of between 10ft. and 84ft., all in accordance with specification and drawings prepared by the Engineers, Messrs. John Taylor and Sons, Artillery House, London, S.W.1.

Specification and drawings obtainable from the Engineers upon payment of £5 (cheque only drawn in favour of above Council) returnable on receipt bona-fide Tender not subsequently withdrawn. Contract documents seen at Engineers' Offices or Council Offices.

Tenders, in plain sealed envelopes, endorsed "Pumping Plant—Contract No. 6," to Clerk of the Council, Council Offices, Woking, by noon, 20th July, 1959. E6066

TENDERS

SURREY COUNTY COUNCIL

(HIGHWAYS AND BRIDGES DEPT)

STAINES BY-PASS

London–Penzance Trunk Road (A.30). TENDERS are invited for the construction of the SOUTHERN APPROACH EMBANKMENT to the proposed new bridge over the River Thames, including a large Roundabout, Dual Carriageways over a length of about 250 yards, a 33ft. span Reinforced Concrete Bridge, a Flood Relief Channel, and other drainage and ancillary works. Documents and drawings, returnable by 15th August, 1959, obtainable from County Engineer, County Hall, Kingston-upon-Thames. E6099

CITY OF LIVERPOOL

TENDERS invited for the SUPPLY and INSTALLATION of ROTARY CUP OIL-BURNING EQUIPMENT on Boiler Plant at three Baths and Wash-house establishments.

Tender forms and all details from the Baths Manager and Engineer, 62, Fontenoy Street, Liverpool, 3.

Tenders returnable by 6th July, 1959.

THOMAS ALKER,
E6707 Town Clerk. (J.5707)

EDUCATIONAL

AUTOMATION.—AUTHORITATIVE COURSES are now available in Digital and Analogue Computer Technology, Applied Electronics, Data Processing and Instrumentation up to professional level by home study. Individual enrolment or industrial group scheme enrolments accepted. Syllabuses and prospectus sent on request.—Write (Dept. S.E.8), E.M.I. Institute School of Electronics, College House, Kensington, London, W.8. E145 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

ELECTRONICS, covering practical and theoretical aspects, basic principles, Industrial applications, electronic apparatus, &c. Guaranteed coaching for Brit.I.R.E., City and Guilds, &c. Study at home under highly qualified tutors.—Write for free book : International Correspondence Schools, 71, Kingsway (Dept. 446A), London, W.C.2. E157 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

APPLICATIONS ARE INVITED from the following Technicians for the Engineering Department at Ferodo Limited, Chapel-en-le-Frith :

DESIGN DRAUGHTSMEN having experience in machine design, works layouts, heating and ventilating, and mechanical services ; also civil engineering design. Ref. E.1.

TOOL DESIGN DRAUGHTSMEN having experience in Jigs, moulding die and press tool design. Ref. E.2.

PROJECT ENGINEERS trained in Production Engineering and capable of dealing with factory layouts, services and special plant design from initial investigation through preparation of estimates and reports to installation and final hand over of plant to the works. Ref. E.3.

CHEMICAL ENGINEERS capable of designing and commissioning chemical plants, including storage, handling, mixing machines and synthetic resin plants. Ref. E.4.

TRAINED METHODS STUDY ENGINEERS having experience in Methods Study practice, with an engineering background and familiar with batch production requirements. Ref. E.5.

ELECTRICAL DESIGN ENGINEERS able to deal with works electrical requirements (A.C. and D.C.) for machine drives, H.V. and L.V. distribution, lighting, electronic controls and instrumentation, &c. Ref. E.6.

In all cases the status will be Technical Officer and there is a contributory pension scheme.

The minimum qualification required is H.N.C. or equivalent, and applicants should reply, quoting Ref. No. and giving age, salary required and details of previous experience, to the Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E6089 A

ASSISTANT ENGINEER required for tube manufacturing concern near Leicester ; age range 23/24. Candidates should preferably have an electrical background, although this is not absolutely essential, and minimum qualifications required are Higher National Certificate or University Degree. The successful applicant will be responsible for new installations and the development of existing plant. This is an interesting opportunity for a young man who wishes to widen his experience in a progressive and stable industry.—Applications, giving full details of experience, qualifications and salary required, should be addressed to the Chief Engineer, TUBES, LTD., Desford Lane, Kirby Muxloe, Nr. Leicester. E6044 A

ASSISTANT TO CHIEF ENGINEER required for Medium/Large Food Factory in Hull. Age 30–40 years. Sound theoretical knowledge of Steam Raising, Refrigeration and Electrical Engineering essential, together with practical experience in at least two of these branches and drawing-office, is required. Previous experience in the successful control of Staff absolutely essential. All applicants must state age, experience and salary required. Write in confidence.—BOX No. E6723, "The Engineer." A

CONSULTING CIVIL ENGINEERS require DESIGN ENGINEERS and R.C. DETAILERS for particularly interesting maritime and/or structural work ; 5-day week, pension, L.V.s. Salary up to £1400, according to experience.—Apply, T. F. BURNS AND PARTNERS, 25, Victoria Street, S.W.1. E2461 A

SITUATIONS VACANT

BP HAS A VACANCY FOR A MARINE ENGINEER in the Technical Services Branch of its Markets Department. The work involves liaison with users and manufacturers of marine engines and marine equipment, with particular reference to the uses of marine lubricants and fuels for industrial and marine diesel engineers. The position will involve travel abroad. Age range 30–40. Qualifications : First Class Ministry of Transport Certificate (Motor and Steam), with preferably a Degree in Mechanical Engineering or its equivalent. A knowledge of languages would be useful. Non-contributory pension scheme. Removal and settling-in allowances payable in certain cases ; luncheon club.—Write, giving full details, quoting reference H.4830, to BOX 6091, c/o 191, Gresham House, E.C.2. E6750 A

CHIEF ENGINEER required by medium-size manufacturing company in the Midlands (employing approximately 1000) to take charge of plant maintenance and new installations in modern factory. Good salary commensurate with qualifications and experience. Superannuation Scheme in operation. Please give full details of age, experience, qualifications and salary required.—BOX No. E2460, " The Engineer." A

COMPRESSOR DESIGNER
and
PNEUMATIC TOOL DESIGNER

The Air Power Division of Joy-Sullivan, Limited, Greenock, have vacancies for :

1. A first-class Engineer, with experience in design of air and gas compressors, reciprocating and rotary.
2. A first-class Engineer, with experience in the design of rock drills and similar pneumatic tools.

Applications are invited from men with at least five years' experience in the design of such machines, and who hold at least Higher National Certificate in Mechanical Engineering. The successful applicants will be required to devote a fair proportion of their time to new development work requiring a high degree of initiative and personal design responsibility, and a good salary will be paid to first-class men.

Please send full particulars to :
The General Manager,
Air Power Division,
JOY-SULLIVAN, LIMITED,
Cappielow,
GREENOCK, Renfrewshire.
E6745 A

CONSULTING ENGINEERS require a number of young, well-qualified, MECHANICAL and ELECTRICAL ENGINEERS in their Nuclear Power Department in London. Those appointed will have the opportunity of gaining experience of the design of reactor types currently being considered for nuclear generating stations, both in the United Kingdom and overseas. Applicants must have a good Honours Degree, and should have served an apprenticeship or have had some practical experience. Suitable nuclear training will be provided where necessary.—Applications, stating age, qualifications and experience, quoting ref. " RFG," to KENNEDY AND DONKIN, 12, Caxton Street, London, S.W.1. E6747 A

DESIGN/DRAUGHTSMAN required by rapidly expanding engineering company for new factory to be erected in East Anglia. The duties and responsibilities require a knowledge of plant layout, mechanical handling, automatic feed mechanisms, coupled with general factory services. Previous experience in these fields essential and require qualifications to H.N.C. level. Knowledge of production engineering or time study would be an advantage. The post initially tenable in Essex and later in East Anglia. The company offer attractive working conditions and operate a part-contribution pensions and life assurance scheme, and a salary commensurate with age, experience and qualifications.—Applications, giving full details of career, should be made to BOX No. E6008, " The Engineer." A

DESIGN DRAUGHTSMAN required for mechanical design of nucleonic instruments. Pleasant working conditions. Excellent rates of pay.—Apply Chief Draughtsman, ISOTOPE DEVELOPMENTS, LTD., Beenham Grange, Aldermaston, Berks. Tel. : Woolhampton 451. E152 A

DESIGN ENGINEER required. Applicants with experience on paper-making machinery preferred.—BOX No. E6047, " The Engineer." A

DESIGNER/DRAUGHTSMAN required for Engineering Firm in London area. Must have expert knowledge of Contractor's Plant in general and Pumps in particular. First-class opportunity for hard working enthusiastic and capable man with ideas to join a progressive organisation. Only applicants with experience of this type of engineering will be considered. A permanent position with good prospects and salary is offered to successful applicant.—Please write, in confidence, stating age, qualifications, past and present positions, and any other worthwhile particulars to BOX No. E2453, " The Engineer." A

DRAUGHTSMAN

Interesting position offered to skilled Draughtsman in Birmingham Organisation handling refrigeration and air conditioning plant.

TECHNICIANS

Development and technical opportunities are also offered in this expanding business.

Write, giving comprehensive but brief details, to Chief Engineer.—BOX No. E2435, " The Engineer." A

EDITORIAL ASSISTANT required for monthly journal specialising in world hydro-electric development. Should be young engineer, preferably civil and with some practical experience, with an aptitude for technical writing. Some knowledge of languages an advantage.—Apply, The Editor, " Water Power," 33, Tothill Street, S.W.1. E6041 A

ENGINEER SURVEYORS required for inspection of Cranes and other Lifting Plant. Must have drawing office experience of design of Cranes, also National Certificate for Mechanical Engineering. Midlands area. Commencing salary £800. Non-contributory pension.—Apply Engineering Department, GENERAL ACCIDENT CORPORATION, LTD., 99, Aldwych, W.C.2. E6701 A

ELECTRICAL ENGINEER, SOUTH AMERICA

A vacancy exists for a SENIOR DISTRIBUTION ENGINEER in a progressive overseas electricity Undertaking. Candidates must possess at least H.N.C. in Electrical Engineering and preferably be Corporate Members of the Institution.

The age limit is about 40 and several years' experience must have been gained in both planning and execution of high and medium voltage transmission and distribution systems.

For the right man, the vacancy is permanent. Full details of age, marital status, education, qualifications and experience, to : Messrs. Mackness and Shipley, Parliament Mansions, Abbey Orchard Street, London, S.W.1, quoting reference 2450. E6706 A

GENERAL MANAGER

wanted for Engineering Factory in Poona with turnover of £1,250,000.

The General Manager will take control of the sub-contracting, planning, buying and administration of the factory and the salary will be commensurate with the nature of this post. Initial contract for three years.

Diesel engine experience or background would be of assistance but not essential. Possibility of Board appointment in due course for right man.

Candidates with suitable experience are invited to apply to James Greaves and Co., 13, Ridgefield, John Dalton Street, Manchester, 2. E6734 A

LEADING LOADING SHOVEL MANUFACTURERS HAS VACANCY for a DESIGN DRAUGHTSMAN for the Design and Progressing of New Developments in Hydraulic Loading Shovels. Applicants should have experience in medium general engineering fabrication and transmission design and should be able to work with a minimum of supervision. H.N.C. minimum qualification.

Apply in writing to Chief Designer, F. E. WEATHERILL, LTD., Tewin Road, Welwyn Garden City, Herts. E5980 A

MARINE SALES ENGINEER required by old-established company of gear manufacturers, to specialise on the sales of marine main drive gear units, present range suitable for tugs, oil tankers, fishing vessels, &c. Previous experience with similar or allied marine products essential. Excellent opportunity for man of initiative, the territory would cover the whole of the United Kingdom. Car provided and expenses. Please apply with full details to Sales Director.—BOX No. E6727, " The Engineer." A

MATERIALS TESTING ENGINEER with theoretical and practical knowledge of Soil Mechanics and a background of mechanical engineering production or design, required by well-established Mechanical Engineering firm engaged in the design and manufacture of materials testing equipment. Duties will include maintaining liaison with customers in educational, research and commercial laboratories, and the organisation of design and development.—BOX No. E2457, " The Engineer." A

MECHANICAL/ELECTRICAL ASSISTANT required by Quantity Surveyors' London Office for Site Measuring and Negotiating Final Accounts. Reasonable knowledge all services, including air conditioning, necessary. Write, stating age, experience in this field and salary range.—BOX No. E2456, " The Engineer." A

MECHANICAL ENGINEER, Degree or A.M.I. Mech.E., to be responsible for design and technical sales of couplings. Previous experience should preferably include responsibility for project development. Competency as a design and development engineer matched with personality and enthusiasm are essential. This is a senior appointment with commensurate salary. Excellent life assurance and pension scheme in operation. Location : Leicestershire. Write fully about your education and career in strict confidence.—BOX No. E6079, " The Engineer." A

METHODS ENGINEER required by Revlon international and expanding cosmetic manufacturers for their British factory in South Wales. Applicants should be qualified in engineering to a standard not less than Higher National Certificate level and should have had some experience or training in work study. This newly created position offers an excellent opportunity to a man between the age of 23 and 30 who can display the necessary drive and ability to get things done. A commencing salary around £1000 per annum or more is envisaged and applicants should write, giving full details of their educational attainments, age and experience in chronological order, to the Works Manager, Revlon International Corporation, Maesteg, Glamorgan. E6757 A

PIPEWORK DRAUGHTSMAN (30–40), H.N.C. or equivalent, is required by a well-known group of companies in the London area. The successful applicant will have considerable experience in the layout of chemical process plant and services. Appropriate salary will be paid. Pension and profit participation schemes in operation.—Write, giving full details of age, experience and qualifications, and quoting reference PWD 30, to BOX No. E6042, " The Engineer." A

SENIOR DESIGNERS required by large light engineering company situated in the East Midlands. Applicants must have had experience in control of a design team and must be capable of initiating original design and its development to production issue stage. The work is concerned with small electrical/mechanical units and equipment, on large-scale batch-production, and an intimate knowledge of design for quantity production is essential. Minimum qualification—an orthodox engineering apprenticeship and H.N.C. in Electrical or Mechanical Engineering. Salary appropriate to qualifications and experience. Pension scheme and generous holiday allowances. Write, giving full details of age, experience, qualifications, &c.—BOX No. E6736, " The Engineer." A

SALES ENGINEER required by old-established company of gear manufacturers to operate from the London Office. If you possess sales experience combined with a mechanical engineering apprenticeship background and real selling ability to expand and maintain an established area then apply with full details of age, experience and education to the London Manager.—BOX No. E6728, " The Engineer." A

SENIOR DRAUGHTSMAN required for North London firm of Mechanical Engineers. Experience in Mechanical Handling and/or Bottling Plant an advantage. Initial salary not less than £1000 p.a. for first class men of initiative and responsibility. Canteen facilities. Pension Scheme.—Apply with full particulars to BOX No. E6026, " The Engineer." A

SENIOR DRAUGHTSMAN/DEVELOPMENT ENGINEER required with experience in machine tools as applied to punching, shearing and guillotine machines. Applicants must have sound workshop and drawing office experience. The position is progressive, offers good opportunities and a good salary will be offered to the right man. DRAUGHTSMAN required with machine tools experience as applied to punching, shearing and guillotine machines. Applicants must have sound engineering training and be prepared to work on own initiative. The above positions are pensionable and in the Manchester area.—BOX No. E6030, " The Engineer." A

SENIOR METHODS ENGINEER required, to take charge of small section responsible for planning of all operations ancillary to machining and assembly of high-speed diesel engines. Experience of modern foundry techniques essential. Preference will be given to applicants who have H.N.C. or equivalent, together with an apprenticeship and subsequent machine shop experience.—Write, giving full particulars and stating salaries earned, to Deputy Manager, Personnel Department, F. Perkins Limited, Peterborough. E6088 A

SHIFT OPERATORS for a plant calcining phosphate rock. Previous experience of oil-firing, instrumentation and operation of furnaces or kilns desirable. Successful applicants would receive instruction and operating experience with a pilot plant in this country and training under a skilled operator on the full-scale plant. Situation Egypt. Duration of contract six/nine months. Fares paid each way, housing and messing all found. Salary, subject to deduction of local income tax, payable in U.K.—Write, full details and salary required, to A. Crookston and Co., Ltd., 38, Grosvenor Gardens, London, S.W.1. E2455 A

STEWARTS AND LLOYDS, LIMITED,

have a vacancy for a

SENIOR

in the Methods Department of their Tollcross Steel Foundry. Applicants should preferably have worked with both alloy and plain carbon steel castings, in the weight range up to 6 tons, but more important is a thorough practical knowledge of modern steel foundry methoding.

Written applications, giving full particulars of Education, Age and Experience, should be addressed to the Manager, Personnel Services, Clyde Tube Works, Coatbridge. E6732 A

THE BEECHAM GROUP have vacancies in the London area for two Senior DRAUGHTSMEN, H.N.C. or equivalent, with experience in plant layout and general engineering. Appropriate salary will be paid. Profit participation and non-contributory pension schemes are in operation. Applications in writing only, giving full details of age, qualifications and experience, and quoting reference SD/31, to be forwarded to the Personnel Controller, Beecham Group Limited, Beecham House, Great West Road, Brentford, Middlesex. E6073 A

UNITED GLASS LIMITED
ST. HELENS
require an additional
DESIGN ENGINEER

who will be engaged in the machine design and development department on specialised equipment used in glass forming processes.

This interesting work affords scope for a young man who has Higher National Certificate in Mechanical Engineering or a higher qualification, capable of creative expression. He will be required to produce detailed drawings and co-ordinate with manufacturing and service departments in the development of these projects.

The successful applicant will be paid a salary commensurate with his qualifications and experience.—Written application, with full details, should be sent to Personnel Officer, United Glass, Ltd., Ravenhead Works, St. Helens. E6710 A

TEST HOUSE ENGINEER required for organising and running of test house in established diesel manufacturing Company in East Anglia. Applicant should have first-class knowledge of test bed procedure, and should also be a fully experienced electrical engineer. Ability and personality to organise and take full responsibility for testing programmes. University or H.N.C. qualifications an advantage. Good salary will be paid to the right man.—Applications in writing, stating age, qualifications and experience to Labour Officer, Box TH775, A.K. Advtg., 212a, Shaftesbury Avenue, London, W.C.2. E6051 A

WORKS MANAGER.—WORKS SUPERINTENDENT required, rapidly progressing to position of Works Manager for expanding company producing aluminium windows and associated aluminium building components.—Write, giving full details of experience, age and salary required, to the Technical Director, Alumin Building Components, Limited, Winterstoke Road, Weston-super-Mare. E2462 A

WORK STUDY.—A major processing company requires a qualified man as head of the Work Measurement Section, in a plant employing over 3000 people. Candidates should be aged 30–45, and should preferably be Graduates in Engineering or Science or A.M.I.Mech.E., although holders of an H.N.C. with a wide background of production experience will also be considered. They must be able to produce evidence of experience in the installation and control of major work incentive schemes in mass production or process industry. Starting salary in the range £1200–£1500, depending upon qualifications and experience. The factory is situated in pleasant rural surroundings and rented houses are available nearby. Send details of career.—BOX No. E6753, " The Engineer." A

YOUNG MEN REQUIRED to train for managerial posts in a progressive steelworks. Preference will be given to applicants holding H.N.C. or equivalent in Metallurgy or Engineering. Previous steelworks experience not essential. Salary will be commensurate with qualifications and experience. These are positions with very good prospects. Staff position, pension and free life assurance schemes, &c. Please apply, stating age, qualifications and experience.—BOX No. E6709, " The Engineer." A

METHODS ENGINEER

required by well-known and progressive marine engineers in the North East.

This new appointment will carry responsibility for jig and tool design, process planning and general production engineering functions.

Minimum qualifications are a heavy engineering background, several years' production engineering experience and good personal qualities.

The Methods Engineer will be responsible to the Works Manager. Salary will reflect this senior status and will depend on experience and qualifications.

Replies will be treated confidentially and should be addressed to :

Production Engineering Ltd.,
12 Grosvenor Place,
London, S.W.1.

in envelopes marked "Methods Engineer."
E6752 A

ROLLS-ROYCE
LIMITED

RESEARCH GROUP OPENINGS

NUCLEAR PROPULSION

Designers :

For varied work currently concerned with advanced reactor systems. Engineering degree or H.N.C. with about 5 years' experience of precision engineering design. In these posts the ability to coordinate information from physicists, metallurgists, chemists and aerodynamicists is required to translate advanced ideas into high quality engineering. Ref. (ATER/4)

Advanced Project Engineers :

For studies in kinetics; automatic control; thermodynamics ; heat transfer ; design and performance analysis of nuclear reactor systems. Ref. (ATER/5)

Common Requirements are imagination and initiative allied with the ability to develop novel ideas with minimum assistance. Emphasis is placed on the fundamental approach and every encouragement for publication of work is given. Successful applicants without nuclear experience will have the opportunity of taking a course.

Location in pleasant residential surroundings on the outskirts of the City.

Written Applications quoting the appropriate reference to :

THE STAFF APPOINTMENTS OFFICER,
ROLLS-ROYCE, LIMITED,
AERO ENGINE DIVISION, P.O. BOX 31, DERBY.

E6712 A

Classified Advts. continued on page 70

SITUATIONS VACANT

GOVERNMENT SERVICE
ENGINEERING DRAUGHTSMEN

Government Communications Headquarters have vacancies at Cheltenham for Mechanical and Electrical Draughtsmen with design experience in any three of the following categories :—

Electronic equipment (rack mounted type, &c.).
Electrical work and small mechanisms.
Micro-wave equipment.
Fabricated parts, sheet metal work, outdoor structures.

Applicants should also have served a recognised engineering apprenticeship or have equivalent workshop knowledge, and preferably hold the Ordinary National Certificate.

There are opportunities for permanent and pensionable appointments and advancement to higher drawing-office posts. Facilities given to study for National Certificates and other Courses in approved cases.

Three-and-a-half weeks' annual leave, plus all public and privilege holidays.

Write to :
Personnel Officer,
G.C.H.Q. (D.O./15),
53, Clarence Street,
Cheltenham,
Glos. E6065 A

SITUATIONS VACANT

INDUSTRIAL SAFETY OFFICER

is required by

THE ENGLISH ELECTRIC COMPANY LTD.

to work at their Atomic Power Station at Hinkley Point, Somerset. Applicants must be capable of advising on all safety requirements covering mechanical and electrical equipment, and previous industrial experience, preferably including site constructional work, is essential.

Please write, giving full details, to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference E1116B. E6735 A

SITUATIONS VACANT

DRAUGHTSMEN
SENIOR AND JUNIOR DRAUGHTSMEN

are required for original and interesting work on marine nuclear propulsion machinery installation.

Applications are invited from suitably qualified Engineering Draughtsmen having held responsible posts in Drawing Office procedure and Contracts work. Marine experience is essential. There are also a few vacancies for Juniors interested in this particular field.

A modern Drawing Office, pleasantly situated on the South Coast, forms a further inducement to enter a new field presenting a constant challenge to ingenuity and design.

Salary will be in accordance with age, experience and qualifications.

Please write with full particulars to :
The Manager,
VICKERS-ARMSTRONGS (ENGINEERS), LTD.,
Oak Yard, Hazel Road,
Itchen, Southampton.

E6719 A

SITUATIONS VACANT

PA
PERSONNEL ADMINISTRATION LIMITED
MANAGEMENT CONSULTANTS

Our Appointments Division has been asked to advise on the following post

GENERAL MANAGER
Packaging Machinery

with prospects of early directorship, is required for a young and growing Company in the London area, manufacturing a wide range of paper and cardboard converting machinery. He will have complete responsibility to the Managing Director for all aspects of production and development. Previous management experience in the industry is essential. This pensionable appointment offers a qualified and experienced mechanical engineer, aged preferably between 35 and 47, an initial salary of up to £3,000. (Ref. 2721/TE)

The identity of candidates will not be revealed to our clients without their prior permission. Applicants should forward brief details quoting the reference number to:

PERSONNEL ADMINISTRATION LIMITED,
APPOINTMENTS DIVISION,
2, ALBERT GATE, LONDON, S.W.1.

E6721 A

AEI

QUALIFIED ENGINEER
for service in INDIA

Wide knowledge and experience of the machine tools and tooling used in the medium/heavy engineering industry essential.

Applicants should have a knowledge of British, Continental and American machine tools, and be able to inspect and report on suitability, accuracy and workmanship of any manufacturer's machine in relation to a specific production requirement. He must also be able to inspect machines and equipment on arrival on site for completeness, or damage ; to supervise installation and lining up, and the commissioning of machines and their tooling for specific jobs.

Three-year contract in first instance. Salary up to £2700, free housing and services, free medical attention, use of car, first class passages each way for engineer and family and other valuable advantages.

Apply stating age, qualifications, experience, family circumstances and names of references to :

Secretary:
A.E.I. OVERSEAS LTD.,
33 Grosvenor Place, S.W.1

E6743 A

FACTORY MANAGEMENT

A British company requires an ambitious GRADUATE ENGINEER of 30 to 35, experienced in production and shop-floor supervision. Starting salary up to £2000 p.a. The responsibilities are considerable and the £4000-£5000 bracket should be reached in a relatively few years. Please send age, education, industrial experience and salary to BOX No. E6703, "The Engineer."

A

ENGLISH ELECTRIC
ATOMIC POWER DIVISION
Whetstone, Near Leicester

wish to appoint a

SENIOR RESEARCH ENGINEER

in the Mechanical Laboratories of the Research and Development Department.

The successful applicant will be required to lead a team investigating problems related to

Friction **Bearings**
Lubrication **Seals**
Wear **Small Prototypes**

Candidates should have some experience in these subjects and a particular interest in one or more of them would be a decided advantage.

Applications are invited from Graduate Mechanical Engineers with a number of years' research experience, and whose background includes some chemistry and electrical engineering.

Please write, giving details of education, qualifications and experience, to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference ER1895E.

E6097 A

NORRIS CONSULTANTS LTD.,

in view of a two-year expansion programme, require for their London and Bristol Offices and elsewhere in the U.K., Senior and Junior Engineers, Designers and Draughtsmen in the following fields.

CIVIL ENGINEERING & SERVICES DIVISION
Reinforced Concrete, Heating, Ventilating, Air Conditioning, Refrigeration, Pipework and General Services, Structural Steelwork, Electrical (Heavy and Light current).

PRODUCTION & MECHANICAL DIVISION
Special purpose machines, Transfer Systems, Jigs and Tools, General mechanical, Mechanical Handling.

Salary scales up to high level in accordance with age, experience, technical and professional qualifications. Pension and Insurance scheme.

Write or telephone : 76, Victoria Street, London, S.W.1. Tel. : VIC 4674, or Beacon House, Queens Road, Clifton, Bristol. Tel. : Bristol 3-6817.

E6087 A

QUALIFIED ENGINEER Reed PAPER GROUP

The Medway Paper Sacks Company of the Reed Paper Group has a vacancy for a **Manager** of their Packaging Machinery Department. Aged about 35-45 years, preferably a qualified Engineer with managerial experience. The factory is situated on the Aylesford Site, near Maidstone, Kent, and the excellent conditions of service include a non-contributory pension fund and an assisted house purchase scheme.

Write for an application form to:—

The Group Personnel Officer,
The Reed Paper Group, Larkfield, Near Maidstone, Kent,
quoting ref. : QE/48

E6713 A

CHEMICAL PLANT ESTIMATORS

Two first-class estimators are required immediately. One senior man with a minimum of 7 years' experience in the estimating of general chemical plant, including structures, with wide general knowledge of estimating in a contracting organization. One junior man with at least 5 years' experience in the specialist field of chemical plant. Good salaries. Good prospects. Generous pension scheme.

Please apply to The General Manager, HUMPHREYS & GLASGOW LIMITED, 22 Carlisle Place, London, S.W.1.

E6722 A

SITUATIONS VACANT

DRAUGHTSMAN

Preferably experienced in machine and detailed design work and plant layout Must have O.N.C. at least and at least 3 years' shop floor experience plus at least 2 years in drawing-office. This is an excellent opportunity in the small drawing-office of an internationally-known manufacturing company in the Outer London area (West) which is engaged in a large modernisation programme. Good conditions of employment. Send full details of age, education, experience and present salary.—BOX No. E6717, "The Engineer."

A

SITUATIONS VACANT

CHIEF DRAUGHTSMAN DESIGNER

Vacancy occurs for an engineer experienced in machine design preferably with reference to foundry equipment though this is not essential. Qualifications should include Higher National Certificate, good drawing office experience and knowledge of work study. Good prospects for man with initiative. Bedford area. Age limit 30–45 years.—BOX No. E6052, "The Engineer."

A

SITUATIONS VACANT

DRAUGHTSMEN

Experienced in the design of compressors or pumps, required by well-established and progressive company situated in the Midlands. Good salary paid to suitable applicants.

Apply BOX No. E6078, "The Engineer."

A

SITUATIONS VACANT

SMITHS MOTOR ACCESSORY DIVISION

LABORATORY ASSISTANTS

EXPERIMENTAL DEPARTMENT

Smiths have a limited number of openings available at their factory at Witney, Oxfordshire. Preference will be given to ambitious young men with relevant experience and Higher National Certificate. In each case a new house (to rent) will be made available to the successful applicant and the commencing salary will be fixed according to previous experience and qualifications.

The Experimental Department is engaged in development work on a variety of products including automatic transmissions for vehicles, heat exchange equipment, combustion heating devices, hydraulic systems, industrial transmission couplings, &c.

The duties of the positions entail actual practical work in the laboratory and preparation of results in report form.

The Company operates a Pension Scheme and a Sports and Social Club. Existing holiday arrangements will be respected.

Applications, in confidence, to

Personnel Manager,
S. SMITH & SONS (ENGLAND) LIMITED
Motor Accessory Division,
Witney, Oxon. E6751 A

Atomic Energy Research Establishment

HARWELL

A PROFESSIONAL ENGINEER is required to manage the engineering services of a large research laboratory used in chemical and metallurgical investigations of radioactive materials. Design and development work in liaison with scientists and project engineers is involved. Experience is needed in the control of technical supervisors and craftsmen and the manufacture, erection and commissioning of equipment.

Salary £845–£1800, depending on age and experience.

Please send a POST CARD for details to The Group Recruitment Officer (1411/25), U.K.A.E.A., A.E.R.E., Harwell, Berks.

E6720 A

ENGLISH ELECTRIC

INDUSTRIAL GAS TURBINE DIVISION

Whetstone, Nr. Leicester

Two new appointments have arisen in this Division.

A DESIGN ENGINEER

is required to undertake work on both mechanical and aerodynamic problems related to Hydrogen Blowers for cooling large alternators and CO_2 circulators for Nuclear Power Stations.

Applicants should possess a degree in mechanical engineering and will have probably served a graduate apprenticeship. Experience in the design of axial flow compressors or related work would be a distinct advantage.

A DESIGN DRAUGHTSMAN

in the same department is required to work on the initial design, layout and complete schemes for gas circulators for Nuclear Power Stations.

Applicants who have served a recognised apprenticeship should be of about H.N.C. level and some experience in air, water or oil installations would be helpful.

Please write, giving details of education, qualifications and experience, to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference ER1896E.

E6098 A

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

A SENIOR INSTRUMENT DESIGNER on the mechanical side is urgently required for interesting work associated with all kinds of instruments. Working conditions are admirable and a staff of draughtsmen is employed. Good dining facilities and a social club are among the amenities. The appointment is in the grade of Senior Technologist and the range of salary is from £1150 to £1500.

Application should be made as soon as possible to the Director, J. Thomson, M.A., D.Sc., M.I.E.E., "Sira," South Hill, Chislehurst, Kent.

E6085 A

PLESSEY NUCLEONICS LIMITED

SENIOR DRAUGHTSMEN

Senior Draughtsmen, with Mechanical, Electrical or Electronic design experience, are invited to apply for vacancies at Northampton. A steady flow of interesting and varied projects is overloading our present staff and we are able to offer attractive positions to suitably qualified men with above-average initiative.

Applicants should possess at least O.N.C. or equivalent and have at least five years' experience in one of the above fields. It is expected that many well-qualified designers will not have had experience in several of the specialised techniques used by the Company. Arrangements have therefore been made to give suitable training in appropriate cases.

Please apply in writing to the Personnel Officer, Plessey Nucleonics, Limited, Weedon Road, Northampton, giving full details of qualifications and experience. Further details of the projects to be undertaken will be discussed with those candidates selected for interview, and every effort will be made to suit the particular interest of each individual. Starting salaries will be in the range £800 to £1100 p.a., according to qualifications and experience.

E6718 A

ENGINEERS

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT ALDERMASTON, BERKSHIRE

To assess the mechanical engineering requirements necessary to meet a tight production schedule; to integrate the production requirements of several divisions into a co-ordinated programme and to make a quick and reliable forecast of requirements from limited information.

A recognised engineering apprenticeship and a wide experience in all aspects of production required. Corporate membership of the Institution of Mechanical Engineers is essential.

Salary: £1345-£1800.

Contributory Superannuation Scheme. A house or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

Postcards for application forms to the Senior Recruitment Officer at above address. Please quote ref. 1939/25.

E6094 A

SITUATIONS WANTED

PRODUCTION ENGINEER (31), H.N.C., &c., 15 years' wide experience in aero, automotive, commercial, precision engineering. Seeks responsible position in production engineering, preferably not aircraft industry.—BOX No. E2451, "The Engineer." B

QUALIFIED ENGINEERING EXECUTIVE, aged 34, with outstanding success record developing new products, markets and production facilities, responsible to Board for creation and management of new Division with six-figure turnover. Seeking position where ability, experience and achievement are well-remunerated. Available October.—BOX No. E2458, "The Engineer." B

ENGINEER (MECHANICAL), 28, A.M.Inst. Mar.E. Present position Engineer Surveyor, desires change. Wide experience plant maintenance seeks position Assistant Engineer or similar.—BOX No. E6730, "The Engineer." B

FOR HIRE

BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone: SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 g

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved.—Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

BUSINESSES and PREMISES

WEST LONDON.—Office accommodation up to 1500 square feet, suitable professional use. No premium. Public transport 3 minutes.—BOX No. E2454, "The Engineer." L

PRECISION ENGINEERING BUSINESS, Monmouthshire. Modern factory premises. Floor space 22,500 square feet. Well equipped plant and machinery. Turnover in the region of £150,000.—Full particulars, HENRY BUTCHER AND CO., 73, Chancery Lane, London, W.C.2. Tel.: HOLborn 8411. E6725 L

Classified Advts. continued on page 72

BUSINESS OPPORTUNITIES

A SMALL ENGINEERING WORKS in South East Lancashire, owned by a Private Limited Company and equipped for a turnover of £100,000 p.a., eminently suitable for a concern that could allocate work to the extent of £50,000 p.a. or over. Alternatively, a firm contemplating permanent extensions. Freehold premises (floor space approximately 32,000 square feet), and also a piece of land for further expansions. The present labour force can be easily reinforced. Present activities cover Tube fabrication up to 12in. n/b. Profile cutting and welding. Plate work and steel assemblies up to 2 tons, with ancillary machine tools. Strict confidence given and expected. Controlling interest or complete take-over. Reply, Managing Director. —BOX No. E6702, "The Engineer." O

ENGINEERING COMPANY with well-equipped Machine Shops and with its own Foundry facilities, seeks NEW IDEAS or the improved application of established principles in the Automotive, Mechanical or Hydraulic Engineering fields. Adequate development resources are available.

Communications from principals only, giving the fullest details of any project, should be addressed to: "Development," BOX No. E6705, "The Engineer." O

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

MISCELLANEOUS

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157-159, Borough High Street, London, S.E.1. E110 I

PLEASE READ THIS . . .

if you are in any way connected with a Sports and Social Club.

We specialise in supplying sports clubs, hospitals and other social groups with our MEN'S SHIRTS and LADIES' BLOUSES at strictly wholesale prices—about 40 per cent below shop prices.

There are many advantages in collective buying and we can supply your club directly from our London factory, provided they order six or more articles at a time. Our shirts are priced from 13/9d. short sleeve and 16/6d. long sleeve. Our blouses, from 10/6d., all London made to highest standards and fully guaranteed.

We should be delighted to send your club secretary a few samples on 7 days' approval, together with a fully descriptive leaflet. Absolutely no obligation, of course.

S. AND L. GILMORE LTD.,
17, TOTTENHAM COURT ROAD,
LONDON, W.1.
Phone: Museum 0415. E2459 I

MACHINERY Etc. WANTED

LABORATORY EQUIPMENT. Wanted—Metallurgical Microscope suitable for micro and macro examination of steel. Camera attachment essential. Full details.—BOX No. E2450, "The Engineer." F

MEI

OPEN TO BUY

ELECTRICAL PLANT
of all kinds.
AIR COMPRESSORS
DIESEL & STEAM
GENERATING SETS

M.E.I. POWER PLANT DIVISION,
Upper Villiers Street · Wolverhampton.
Tel: 26354–7
E6711 F

FOR SALE

VERY FINE 35-TON ELECTRIC PORTAL WHARF CRANE, built 1945. Lift 35 tons at 60ft. radius to height 75ft. Portal 40ft. track, admitting three rail tracks. Electrics 400-3-50. Seen working.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
LONDON, S.E.18.
Telephone: Woolwich 7611/6.
E5992 G

15 CWT. PNEUMATIC HAMMER, by Ross. Had little use.—BOX No. E6754, "The Engineer." G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia. 100/150 lb w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Bellis & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted 30ft.–70ft. extendible jib; 10-ton 33 R.B. track mounted, 40ft. jib; 8½-ton Ransomes Diesel/Electric, 21ft. jib; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2); 6-ton Coles Diesel/Electric, solids; 4-ton Coles Diesel/Electric, solids, 1945; 4-ton Jones KL44, diesel, 1950; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—40-ton Babcock, 40ft. span, 400/3/50, "Goliath"; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6); 20-ton King, 42ft. 3in. span, 400/3/50; 15-ton Morris, 35ft. span, hand operated; 10-ton Morris, 45ft. span, 36ft. lift; 10-ton Morris "Goliath," 40ft. span, 400/3/50; 10-ton Vaughan, 23ft. 6in. span, 400/3/50; 10-ton Vaughan, 21ft. span, 44ft. lift; 7½-ton Wharton, 25ft. span, 400/3/50; 5-ton Henderson, 24ft. 7in. span, 1946; 5-ton Morris, 58ft. span, hand operated; 5-ton Royce, 2-motor crab, 440/3/50; 5-ton King, 29ft. 3in. span, power hoist, hand travel; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel; 4-ton Morris, 19ft. span, 220V, d.c. (3); 3-ton Adamson, 48ft. span, 400/3/50; 2-ton Adamson, 34ft. span, 400/3/50 (2); 2-ton Morris, 18ft. span; 2-ton Vaughan, 27ft. 6in. span, 2-motor; majority of the above are unused.

DERRICK CRANES.—7-ton Rushworth hand 30ft. jib; 5-ton Wilson Electric, 70ft. jib; 1½-ton Anderson Grice, hand, 40ft. jib.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Coles steam 40ft. jib; 10-ton Grafton, 34ft. jib, diesel conversion; 8-ton Wilson steam, 35ft. jib; 5-ton Grafton, 35ft. jib, diesel conversion; 5-ton Smith, 50ft. jib (2); 5-ton Cowans Sheldon, 50ft. jib.

LOCOS.—Fowler diesel, 150 h.p. (2); Ruston diesel, 80/88 h.p., new 1942; Bagnall 14in. by 22in., two oil fired, one coal; Peckett steam, 7in. by 12in., 1941; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised new; 60,000ft., 3in. black, new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot, New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in.; Robertson Straightening Rolls, 8ft. 6in. by ¼in.; Berry Bending Rolls, 7ft. by ¼in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers; Bliss 14T Tapering Press; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore; Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists; two 40kVA. Spot Welding Machines; Wire Drawing Machine, 3 die up to ¾in. copper; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
Phone: Coleford 2271/2. E106 G

600
BOILERS

TWO COCHRAN "SINUFLO" double-pass, 10ft. 9in. by 15ft. 8in. by 22ft. 7in., 16,800/18,000 lb/hr., 120 p.s.i.
JOHN THOMPSON treble-pass, super economic, 11ft. by 16ft. by 21ft., 14,500/15,150 lb./hr., 120 p.s.i.
TWO FOSTER YATES AND THOM double-pass, 9ft. 9in. by 15ft. 6in. by 20ft. 6in., 12,000 lb./hr., 160 p.s.i.
TWO JOHN THOMPSON treble-pass, 9ft. 6in. by 14ft. by 19ft., 9500 lb./hr.
Oil-firing or automatic stokers can be supplied with above.

GEORGE COHEN,
Sons and Co. Ltd.
Wood Lane, London, W.12
(Shepherds Bush 2070).
Stanningley, Nr. Leeds.
(Pudsey 2241.) E203 G

FOR DISPOSAL.—Quantities of Steel and Iron Rivets, Nuts and Bolts. For further details of quantities, sizes and prices, apply Ref. "P/EB," APPLEBY-FRODINGHAM STEEL COMPANY, Scunthorpe, Lincs. E6090 G

FOR SALE

Edwards

TAYLOR & CHALLEN No. 576 Open Fronted Inclinable Power Press with detachable front tie bars, pressure exerted approximately 20 tons, stroke 3in., tee-slotted bed 27½in. by 22½in.

INCANDESCENT Forced Draft Bar Heating Furnace, double ended, gas fitted, heating chamber 36in. wide by 24in. deep by 9in. high, total length through furnace 32in. working, temperature range 900 deg. to 1350 deg. C., 1200 deg. C. can be reached in about 1¼ hours after starting from cold.

TAYLOR & CHALLEN No. 3 G.D.P. Geared, Double Sided, Double Action, Cam Action Drawing Press, arranged motor drive for 400/440/3/50, punch stroke approximately 7in., blankholder stroke approximately 3¼in., tee-slotted bed 18in. by 15¼in., between uprights 20¼in., weight approximately 51 cwt.

QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. diameter, weight approximately 18 cwt.

RHODES Motorised Double Geared Press Brake, with cast iron side frames, reinforced by nickel-chrome steel bars, bed and top beam are of steel plate, arranged motor drive for 400/3/50, pressure exerted 150 tons, forming capacity 10ft. by ⅜in. or 18ft. by approximately ¼in., clear width between housings 10ft. 2in., weight approximately 20 tons.

NEW MUBEA Model KSG100 All-Steel Construction Bar and Angle Shear, the flywheel is situated inside the body, arranged motor drive suitable for 400/3/50, capacity: round bars 2in.; square bars, 2in.; flat iron, 10in. by ¾in.; 5¼in. by 1in., angles up to 4in. by ½in., 5in. by 0·425in.; tee iron 5in.; beams 6in.; channels 6in.; length of blades 12⅝in.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
Telephone: EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone: Central 7606–8. E207 G

FOR SALE

Murex diesel Welding Sets 300/400 amp. Perkins P4 engines.
Quantity of Guyrex and RMD Shuttering.
3-tool BroomWade 167 cu. ft. Portable diesel Compressor Set on pneumatics with over-run brakes.
5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
6-ton Ransomes and Rapier Standard and Super pet./elec. Mobile Cranes (diesel conversion available).
3 cu. yd. and 4½ cu. yd. Aveling-Barford diesel-driven Dumpers.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
¾ cu. yd. Rapier 423 diesel-driven Excavator with shovel equipment.

WILLIAM G. SEARCH LIMITED
WHITEHALL ROAD, LEEDS, 12.
Tel.: 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel.: Simonswood 3361 (5 lines).
E6726 G

HYDRAULIC PRESSES
HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings, New and Second-hand. Complete installations.
All kinds of Hydraulic Equipment in Stock.

THOMPSON AND SON (MILLWALL), LTD.,
Cuba Street, Millwall, London, E.14.
East 1844/5. E111 G

3 HIGH ROLLING MILLS

One 3 High Rolling Mill, rolls 15in. diameter by 36in. face, mounted in Timken bearings, complete with pinion housing, reduction gearbox, 150 H.P. motor and starting equipment. A spare motor and spare bearings are also available. In excellent condition, ready for putting into operation.—For further details and price apply The United Wire Works, Ltd., Granton, Edinburgh, 5. E6740 G

600 H.P. TOTALLY ENCLOSED OIL-COOLED ROLLING MILL REDUCTION GEAR, by Turbine Gears; ratio 730/38 r.p.m. Unused.

F. BURRILL AND CO.,
235A, CATHEDRAL ROAD, CARDIFF.
Tel.: 26100. E6001 G

BULL BLOCKS

Two single die heavy Bull Blocks for drawing rod and wire. Block diameter 26in., speed 250ft. per minute, fitted with 60 H.P. motors and contactor starting equipment. In first-class condition, ready for bringing into operation.—For further details and price, apply The United Wire Works, Ltd., Granton, Edinburgh. E6741 G

FOR SALE

600
ALTERNATOR SETS

UNUSED 979kVA, 6·6kV, 3-phase, 50 cycles DIESEL ENGINE DRIVEN ALTERNATOR SET incorporating engine by Mirrlees, Bickerton and Day, type JV.16; 16-cylinder, speed 750 r.p.m., developing 1120 h.p. Direct coupled to alternator by Brush Electrical revolving field, mounted on soleplates with direct coupled exciter. Engine complete with standard ancillaries, alternator with switchboard by Reyrolle with automatic voltage regulator.
500kW, continuous 24-hour duty, 380/400 volts, 3-phase, 50 cycles DIESEL ENGINE DRIVEN ALTERNATOR SET, direct coupled at 375 r.p.m. and comprising 750 h.p. Belliss and Morcom 7-cylinder vertical engine, complete with ancillaries, starting equipment. Direct coupled to alternator by Lancashire Dynamo Company, complete with switchgear.
TWO 1000kW, 3·3kV, 3-phase, 50 cycles back pressure type STEAM TURBO ALTERNATOR SETS each incorporating turbine by Belliss and Morcom, speed 4500 r.p.m., steam pressure 195 p.s.i., 380 deg. Fah. temperature, exhausting against 15 lb. back pressure. Direct coupled through David Brown gearbox ratio 4·5 : 1 to alternator by Harland Engineering Company with direct coupled exciter. Each complete set mounted on cast iron baseplate and complete with switchgear with automatic voltage regulator, also hand-operated overhead crane.
675kW, 400 volts, 3-phase, 50 cycles, 4-wire back pressure type STEAM TURBO-ALTERNATOR SET comprising turbine by Belliss and Morcom, 150/200 p.s.i. initially, exhausting against 10/15 lb. back pressure. Direct coupled through David Brown gearbox to alternator by Brush Electrical Company. With switchgear.

GEORGE COHEN,
Sons and Co. Ltd.
Wood Lane, London, W.12.
(Shepherds Bush 2070)
Stanningley, Nr. Leeds.
(Pudsey 2241.) E201 G

FOR SALE

Danks 7ft. diameter by 15ft. 6in. long High-velocity Economic Boiler, 3600 lb. evaporation, 300 p.s.i. working pressure, with Oldbury Chain Grate Stoker. New 1952.
Danks 7ft. 6in. dia. by 14ft. Medium Velocity ditto, about 4500 lb. evaporation, 100 p.s.i. working pressure. With Oldbury Chain Grate Stoker. New 1952.

JOSEPH PUGSLEY AND SONS LIMITED, BRISTOL, 5.
Tel.: Bristol 56037. E6075 G

FOR SALE

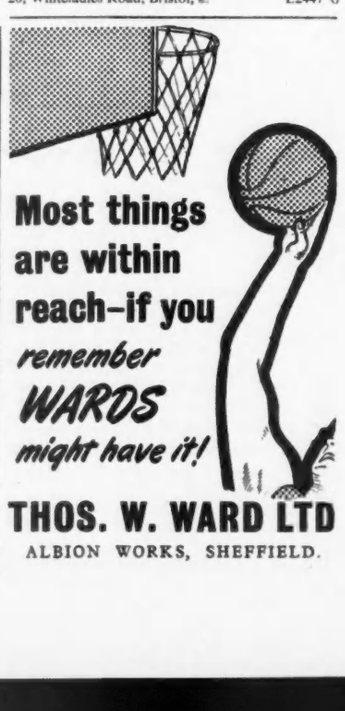
TURRET LATHE

CHURCHILL-REDMAN 24in. Surfacing, Boring and Screwcutting TURRET LATHE, swing 38in. by 19in. in gap.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
EUSton 4681 and 3771.
E6095 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent Tel.: Bexleyheath 305). E113 G

2½-TON MORRIS MOBILE CRANE, unused and guaranteed as new, at half list price.—Davies, 20, Whiteladies Road, Bristol, 8. E2447 G



AUCTIONEERS & VALUERS

ESTABLISHED 1877

LEOPOLD FARMER & SONS

conduct

AUCTION SALES

and

VALUATIONS

OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES

FACTORY INVESTMENTS
MORTGAGES ARRANGED

46, GRESHAM STREET, LONDON, E.C.2.

Telephone : Monarch 3422 (8 lines) Telegrams : Sites, London

HENRY BUTCHER AND CO.

Auctioneers, Valuers and Surveyors

Specialising in the

SALE & VALUATION

of

ENGINEERING & ALLIED WORKS PLANT & MACHINERY

73, Chancery Lane, London, W.C.2.

HOLBORN 8411 (8 lines)

FOR SALE

MACHINERY AND EQUIPMENT FOR SALE

1 Six Spindle Acme Gridley Bar Auto., 1¼in. capacity (American built).
2 Hahn and Kolb Collett Lathes, 1in. capacity, Type R25.
1 Murad High-Speed Collett Lathe, 1in. capacity.
1 Alfred Herbert High-Speed Pillar Drill.
1 Denbigh Milling Machine, 30in.
1 Edgwick Collet Lathe, 1¼in.
1 B.S.A. 6in. Production Lathe with new air chuck and tailstock.
1 Alfred Herbert Pillar Die Grinder.
2 Herbert Die Heads—¼in. automatic.
Quantity Steinle Thread Rollers.
Quantity of Collets, Feed Fingers, &c., for Cone Automatics, 4 spindle 1¼in.

BOX No. E2446, "The Engineer." G

HYDRAULIC FORMING AND FORGING PRESSES

3000-ton Down-stroke PRESS for HEAVY PLATE FORMING AND BENDING, 3 rams ; admitting 10ft. 6in. between columns ; bed 16ft. by 8ft.
2000-ton Down-stroke FORGING PRESS, 5ft. stroke ; bed 8ft. 6in. by 8ft. ; daylight 11ft.
1000-ton Down-stroke FORGING PRESS by Wellman, bed 7ft. by 6ft. ; daylight 9ft.
475-ton FLANGING PRESS by Hugh Smith, table 10ft. dia., 4 vice rams.

REED BROTHERS (ENGINEERING) LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6

E5991 G

ONE 10-TON ELECTRIC LUFFING AND TRAVELLING JIB CRANE by Cowans, Sheldon and Co., Ltd. 50ft. maximum radius of jib, maximum lift above rail level 45ft., motorised 230 volts d.c.

JOHN CASHMORE, LTD.,
NEWPORT, MON. E154 G

AUCTIONEERS & VALUERS

Established 1807

FULLER, HORSEY SONS & CASSELL

Specialists

IN THE

SALE & VALUATION

OF

WORKS and MANUFACTORIES
ENGINEERING PLANT
and MACHINERY

10, LLOYD'S AVENUE
LONDON, E.C.3.

Telephone : ROYAL 4861

Established 1850

WHEATLEY KIRK PRICE & CO.

E. L. JUDSON, F.R.I.C.S., F.A.I.
E. BEDDARD, A.I.MECH.E., F.A.I., F.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.I., F.P.A.

SURVEYORS, VALUERS and AUCTIONEERS of FACTORIES, PLANT and MACHINERY

FIRE LOSS ASSESSORS

9, REX PLACE, LONDON, W.1.
Telephone : HYDE PARK 8844/5/6 (3 lines)

Chamberlain & Willows will SELL by AUCTION at the CITY AUCTION HALL, 58, COLEMAN STREET, E.C.2, on THURSDAY, 25th JUNE, 1959, at 4 p.m.,

SIX FREEHOLD INDUSTRIAL PROPERTIES

IN CENTRAL LONDON,

including :

ENGINEERING WORKS, Larcom Street, Walworth, S.E.17, with good lofty buildings—Floor area 11,900 square feet, and steel stock yard of 8900 sq. ft.

Five vehicle entrances. 4 travelling cranes.

Also

At Poplar	Modern Factory	26,000 sq. ft.
At Holborn	Warehouse	22,500 sq. ft.
At Southwark	Factory	26,000 sq. ft.
At Camberwell	Ditto	10,750 sq. ft.
At Barnes	Ditto	13,900 sq. ft.

Full details from :
23, Moorgate, E.C.2.
Tel.: MET 8001–10 lines.

E6086 J

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

800-ton Fielding Vertical 4-column Downstroke Hydraulic Press, ram 23in. dia. by 14in. stroke, Daylight 2ft. 3in., Platens 5ft. 4in. by 4ft. 4in., with 2 pumps and controls, motorised 400/3/50.
Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.
Available at low prices ex present sites to save cost of bringing into stock.

FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. E151 G

AUCTIONEERS & VALUERS

JOHN FOORD & COMPANY

VALUERS AND ASSESSORS

OF WORKS, FACTORIES ENGINEERING PLANT AND MACHINERY

56, VICTORIA STREET, LONDON, S.W.1.

VICTORIA 2002/3/4

Established Over a Century

AUCTIONEERS & VALUERS

By Order of the Owners.
CROYDON, SURREY

MACHINE TOOLS AND ENGINEERING PLANT

S.S. and S.C. Lathes, 2nd Operation Lathes, Ward No. 3A, Capstan Lathes, Cylindrical and Surface Grinders, POWER PRESSES, to 60 tons capacity, Air and Fly Screw Presses, Horizontal and Vertical Milling Machines, Single and Multi-Spindle Drills, Chrome and Nickel Plating Plants, SPRAYING AND POLISHING PLANTS, Electric Bench Drills and Tapping Machines, Shaping and Slotting Machines, Electric and Oxy-Acetylene Welding Units, Stocks of Cutting Tools and Machine Equipment, All Electric Canteen Equipment, Drawing Office Furniture, Benches, Racking, Time Clocks, Scales and Loose Effects.

Leopold Farmer & Sons will sell the above BY AUCTION on the Premises,
VICTORY WORKS, GLOUCESTER ROAD,
WEDNESDAY, 22nd JULY, 1959,
at 11 a.m.
On View 2 Days Prior and Morning of Sale.

Note : The FREEHOLD PROPERTY with a floor area of 50,000 square feet, also Freehold Industrial Site and Dwelling Houses will be offered at the same time.

Catalogues (price 6d.) each of : Leopold Farmer and Sons, Industrial Property, Plant and Machinery Auctioneers, Surveyors and Valuers, 46, Gresham Street, London, E.C.2. Tel. : MONarch 3422 (8 lines). E6749

YORKSHIRE
13 miles East of Hull
Agricultural or Light Industrial Property
FORMER B.B.C. SITE

OTTRINGHAM

Over 38,000 sq. ft.
Substantial Brick and Concrete Buildings,
including power-house, four transmitter rooms, and control centre, which could be used as a farmhouse or offices. Main Water and Electricity. Modern Drainage.
WITH VACANT POSSESSION OF ALL THE BUILDINGS
(excepting the Electricity Sub-Stations)
TOTAL 95 ACRES
For SALE BY AUCTION as a WHOLE or in TWO LOTS
At THE IMPERIAL HOTEL, HULL, on WEDNESDAY, 24th JUNE, 1959, at 3 p.m.
(unless previously sold).

Solicitor : Mr. E. C. Robbins, C.B.E., Broadcasting House, Portland Place, W.1 (LAN 4468).
Auctioneers : KNIGHT, FRANK & RUTLEY, 20 Hanover Square, W.1. (MAY 3771).

E6739 J

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
June 25–26	**Machine tools and miscellaneous stores,** including :	Hawker Aircraft Factory, **South Shore, Blackpool.**	**LESLIE A. BUTSON** (Dept. L), 16, Birley Street, Blackpool. (Tel.: 21073.)
	vertical, radial, horizontal and bench drilling machines ; presses ; welders ; weighing machines and scales ; garage equipment and vehicle spares ; factory and office furniture ; hand trucks ; sectional steel binning ; steel storage racks ; time recording systems ; sectional offices ; wooden partitioning, etc.		
June 30–July 3	**Machine tools and miscellaneous stores,** including :	M.O.S. Storage Depot, **Royal Arsenal, Woolwich, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, E.C.3. (Tel.: Royal 4861.)
	Cincinnati planing machine ; lathes ; horizontal and vertical milling machines ; slotting, shaping, drilling and hacksawing machines ; Bliss No. 25½ rigid power press ; fork lift trucks ; generating and charging sets ; road roller ; cranes ; crawler tractor with dozer equipment ; tar and bitumen distributors ; pumping sets ; building materials and ironmongery stores ; engineers' hand tools ; tool kits ; radio and electrical equipment ; field telephones ; binoculars and compasses ; theodolites ; microscopes ; telescopes ; medical stores ; service clothing ; barrack room furniture ; 2500 iron shod 10ft. ash levers, etc.		
July 14–15	**Vehicles, M.T. spares and miscellaneous stores.**	Central Ordnance Depot, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
July 16–17	**Miscellaneous stores,** including hand tools, large quantity of paint, etc.	Central Ordnance Depot, **Didcot, Berks.**	**SIMMONS & SONS** (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
July 23	**Miscellaneous stores.**	M.O.S. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept L), 20, King Street, Hereford. (Tel.: 4366.)
July 28	**Miscellaneous stores.**	Command Ordnance Depot, **Hilsea, Portsmouth, Hants.**	**HALL, PAIN & FOSTER** (Dept. L), 54–60, Commercial Road, Portsmouth. (Tel.: 24421.)

Applications for catalogues, available 14 days prior to date of sale, should be made *only* to the auctioneers shown above (price of catalogue 1s. 0d., P.O. only).

SALES BY TENDER

1. 16 G.M.C. 6-cylinder Diesel Engines, Model 6062 and 75 G.M.C., 12-cylinder twin Diesel Power Units, located at M.T. Stores Depots Bordon and Derby.

Tenders must be submitted by 7th July, 1959.

2. 95 Five Bank Decimal Digitisers (Diprose Type), located at Farnborough, Hants.

Applications for Tender Forms, stating which tender is required, should be made to the Ministry of Supply, Directorate of Disposals, First Avenue House, High Holborn, London, W.C.1.

E118 J

One of our wide range of Steel Castings: Live Ring for Rotary Furnace Chamber, Weight: 31 tons

Cast Steel Rings up to

23 feet diameter

ROTARY BODIES
FLYWHEELS etc.

carbon and alloy,
annealed, heat treated,
rough and finished machined

Bochumer Verein
für Gußstahlfabrikation AG. BOCHUM

Representatives for the U.K.: **THE STAHLUNION COMPANY LIMITED. 61 Pall Mall, London, S.W. 1**

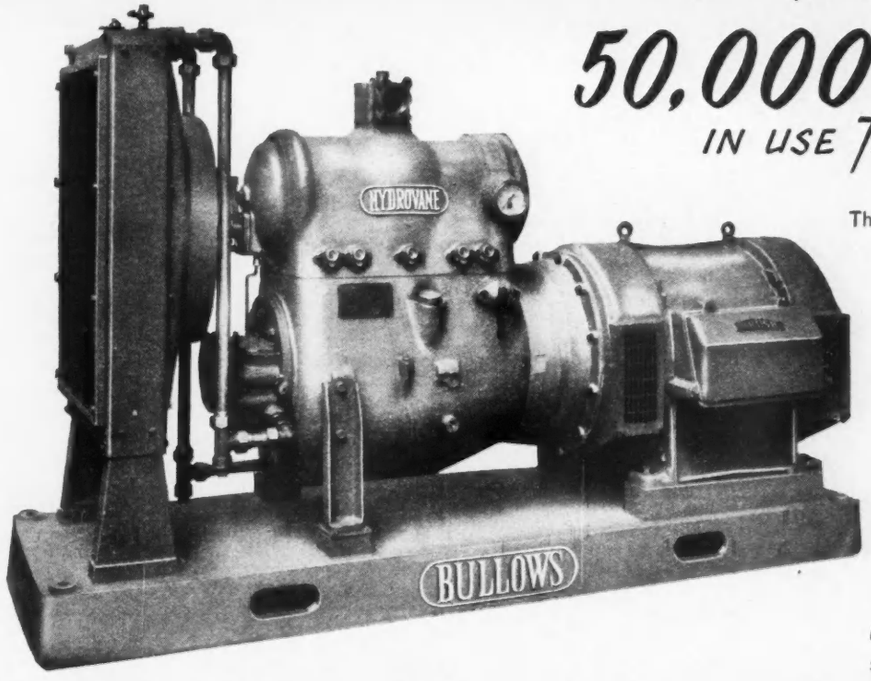
INDEX TO ADVERTISERS

	PAGE
AB Atlas Copco/Sweden	Cover ii
Abbott & Co. (Newark), Ltd.	39
Acme Flooring & Paving Co. (1904), Ltd.	32
Adamson, J., & Co., Ltd.	50
Airscrew Co. & Jicwood, Ltd.	76
Albion Engineering Co., Ltd.	40
Albright & Wilson (Mfg.), Ltd.	9
Anderson, C. F., & Son, Ltd.	45
Appleby-Frodingham Steel Co.	44
Arup & Arup, Ltd.	52
Ash, J., & Son, Ltd.	11
Ashmore, Benson, Pease & Co.	17
Austin, E., & Sons (London), Ltd.	75
Automation, Ltd.	56
Automotive Products Co., Ltd.	6
B.A. Holland Engineering Co., Ltd.	33
BICC Group	42
Bailey, Sir W. H., & Co., Ltd.	2
Barron, W. S., & Son, Ltd.	51
Beardmore, W., & Co., Ltd.	25
Bochumer Verein	74
Booth, J., & Bros.	38
British Appliances Mfg. Co., Ltd.	75
British Ermeto Corporation, Ltd.	7
British Steam Specialties, Ltd.	52
Broom & Wade, Ltd.	21
Brown, Boveri & Co., Ltd.	63
Brown, D., Corporation (Sales), Ltd.	51
Brown, N. C., Ltd.	65
Brownlie & Murray, Ltd.	15
Bullows, A., & Sons, Ltd.	75
Butcher, H., & Co.	73
Carlisle, C. G., & Co., Ltd.	34
Carruthers, J. H., & Co., Ltd.	32
Carter, B. & F., & Co., Ltd.	54
Chatwin, T., & Co.	33
Clyde Crane & Booth, Ltd.	38
Clyde Crane & Engineering Co.	38
Colt Ventilation, Ltd.	3
Crane, Ltd.	61
Crofts (Engineers), Ltd.	36
Cross Manufacturing Co. (1938), Ltd.	52
Cuxson, Gerrard & Co., Ltd.	32
Eclipse Foundry & Engineering Co. (Dudley), Ltd.	35
Edwards, L., & Co. (Engineers), Ltd.	12
Electrical Power Engineering Co. (B'ham), Ltd.	12
Electro-Dynamic Construction Co., Ltd.	54
Evans, F. W., Ltd.	10
Farmer, L., & Sons	73
Ferranti, Ltd.	23
Fielding & Platt, Ltd.	57
Filton, Ltd.	11
Firth, T., & Brown, J., Ltd.	18
Fleming & Ferguson, Ltd.	39
Fluxite, Ltd.	61
Foord, J., & Co.	73
Ford Motor Co., Ltd.	33
Fuller Horsey, Sons & Cassell	73
General Electric Co., Ltd.	8
Greenwich Insulation Co., Ltd.	41
Griffiths, Gilbart, Lloyd & Co., Ltd.	54
Guest, Keen Iron & Steel Co., Ltd.	6
Hall & Hall, Ltd.	31
Harvey, G. A., & Co. (London), Ltd.	49
Hayward, E., & Co. (Fabrications), Ltd.	40
Higgs Motors, Ltd.	4
Hobson, H. M., Ltd.	30
Hoffmann Manufacturing Co., Ltd.	Cover iii
Holcroft, T., & Sons, Ltd.	65
Holst & Co., Ltd	Cover iii
Hudswell Clarke & Co., Ltd.	56
Hunt & Moscrop, Ltd.	15
Ince Forge Co., Ltd.	50
Imperial Chemical Industries, Ltd.	24
International Combustion Products, Ltd.	48
Kay & Co. (Engineers), Ltd.	11
Lafarge Aluminous Cement Co., Ltd.	37
Lancaster & Tonge, Ltd.	15
Lewis & Tylor, Ltd	56
Lindemann Kommanditgesellschaft	13
London Electric Firm, Ltd.	53
Maag Gear-Wheel Co., Ltd.	59
Marshall Fleming & Co., Ltd.	31
Maxseal Valves, Ltd.	10
Metropolitan-Vickers Electrical Co., Ltd.	20
Micanite & Insulators Co., Ltd.	50
Mirrlees, Bickerton & Day, Ltd.	16
Moffat & Bell, Ltd.	13
Mond Nickel Co., Ltd.	Cover i
National Steel Foundry (1914), Ltd.	58
Newalls Insulation Co., Ltd.	65
Newbury Diesel Co., Ltd.	54
Nitralloy, Ltd.	31
Norris Bros., Ltd.	39
Osborn, S., & Co., Ltd.	46
Parker, F., Ltd.	58
Payne & Griffiths, Ltd.	10
Peart, E., & Co. (Electronics), Ltd.	2
Power-Gas Corporation, Ltd.	17
Power Petroleum Co., Ltd.	28
Pinchin, Johnson & Co.	59
Pioneer Oilsealing & Moulding Co., Ltd.	39
Plenty & Son, Ltd.	5
Pool, J. & F., Ltd.	35
Potter, F. W., & Soar, Ltd.	50
Press & Shear Machinery Co., Ltd.	62
Priest Furnaces, Ltd.	56
Prodorite, Ltd.	45
Quasi-Arc, Ltd.	47
Ratcliffe, F. S. (Rochdale), Ltd.	62
Richardsons Westgarth & Co., Ltd.	66
Saunders Valve Co., Ltd.	64
Savery, T., Pumps, Ltd.	62
Schieldrop & Co., Ltd.	40
Schmitt, Ed., & Cie., G.m.b.H.	59
Scriven Machine Tools, Ltd.	35
Smith, T., & Sons (Rodley), Ltd.	Cover iv
Smedley Bros., Ltd.	12
Smethwick Drop Forgings, Ltd.	19
Spencer - Bonecourt - Clarkson, Ltd.	29
Steels Engineering Installations, Ltd.	14
Strachan & Henshaw, Ltd.	27
Sulzer Bros., Ltd.	43
Sundwiger Eisenhütte	8
Swiss Industrial Co.	55
Swiss Locomotive & Machine Works	53
Taylor & Challen, Ltd.	29
Technical Applications, Ltd.	10
Teleo, Ltd.	54
Thompson, J., Group	22
Thornton, B., Ltd.	26
Tilghman's, Ltd.	52
Turbine Furnace Co., Ltd.	61
United Steel Companies, Ltd.	44
Vokes, Ltd.	60
Walker Bros., Ltd.	15
Ward, T. W., Ltd.	35-72
Warren-Morrison, Ltd.	12
Welch, J. A. (Plant & Vessel), Ltd.	31
Wheatley Kirk, Price & Co.	73
Wilkinson Rubber Linatex, Ltd.	40
Wills, W. & F., Ltd.	56

OIL-SEALED ROTARY COMPRESSORS

HYDROVANE BULLOWS

FROM 1/3-250 h.p.



50,000 IN USE throughout the World!

The Hydrovane principle was developed and introduced by Bullows in 1948 and has since been adopted by all the major manufacturers *throughout the World!*

10 Licencees manufacturing Hydrovane Compressors *throughout the World!*

For further details of the Hydrovane principle send for our "Questions & Answers" Folder

A. BULLOWS & SONS LTD · LONG ST · WALSALL · STAFFS · TEL. 5401

absterge

(to clean by wiping)

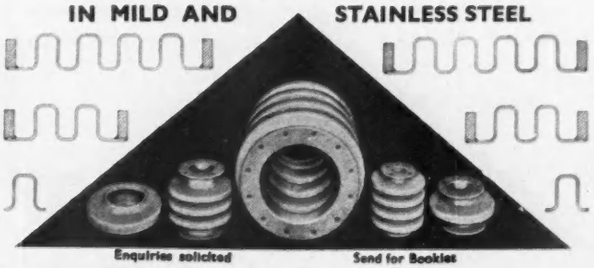
Austins supply the best cleaning rags for every purpose. Some jobs call for coarse, heavy fabric, some for soft, closely woven materials—we can meet all requirements with carefully selected rags that are thoroughly washed and sterilized in our own plant. Orders of all sizes are handled with promptness and reliability. Please let us quote you for regular supplies.

AUSTINS industrial cleaning rags

E. AUSTIN & SONS (LONDON) LTD., GUN WHARF, GUNMAKERS LANE, E.3 · Tel: ADVance 1211

ROSE'S EXPANSION PIECES

PRESSED STEEL BELLOWS TYPE IN MILD AND STAINLESS STEEL



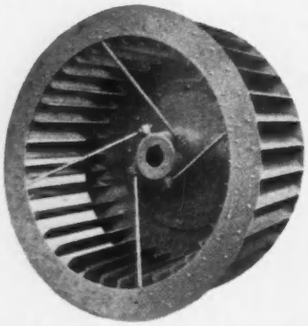
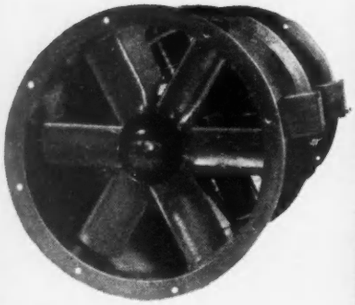
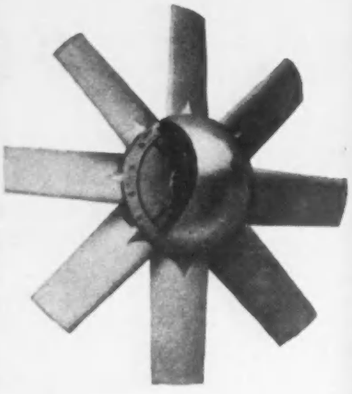
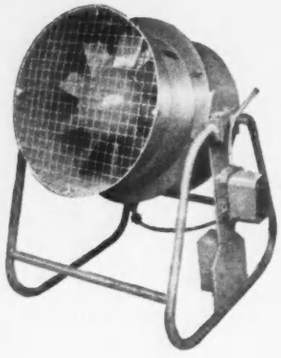
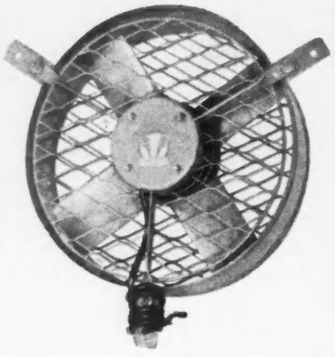
also AIR RECEIVERS, CHIMNEYS, TANKS, PIPE WORK, PRESSURE CYLINDERS, AND FABRICATED STEEL PLATEWORK

BRITISH APPLIANCES MFG. CO., LTD.

DOLLY LANE, LEEDS, 9

Telephone: 30725 Telegrams: STRUCTURAL LEEDS 9

The fan you need...

In the time you need it!

Airscrew can provide the right fan, at the right time, from their Standard Axial Flow and Centrifugal range. Held ready for quick assembly is a comprehensive selection of Axials (ranging from 12" to 27") and Centrifugals (including all types of forward curve, backward curve and paddle blade fans).

From among this range, the Airscrew Technical Service can help you to select the right fan for the job in hand. It can also be of great assistance when you need a fan of special design. So, consult Airscrew first! You can depend on an Airscrew fan being *guaranteed to give its rated duty.*

STANDARD FANS

Airscrew

An Airscrew specification means what it says

THE AIRSCREW CO. & JICWOOD LTD · WEYBRIDGE · SURREY · Tel: WEYBRIDGE 2242/7 ▶ ***Manufacturers of all types of Axial Flow, Centrifugal, Aircraft and Cooling Tower Fans***

WPS—91

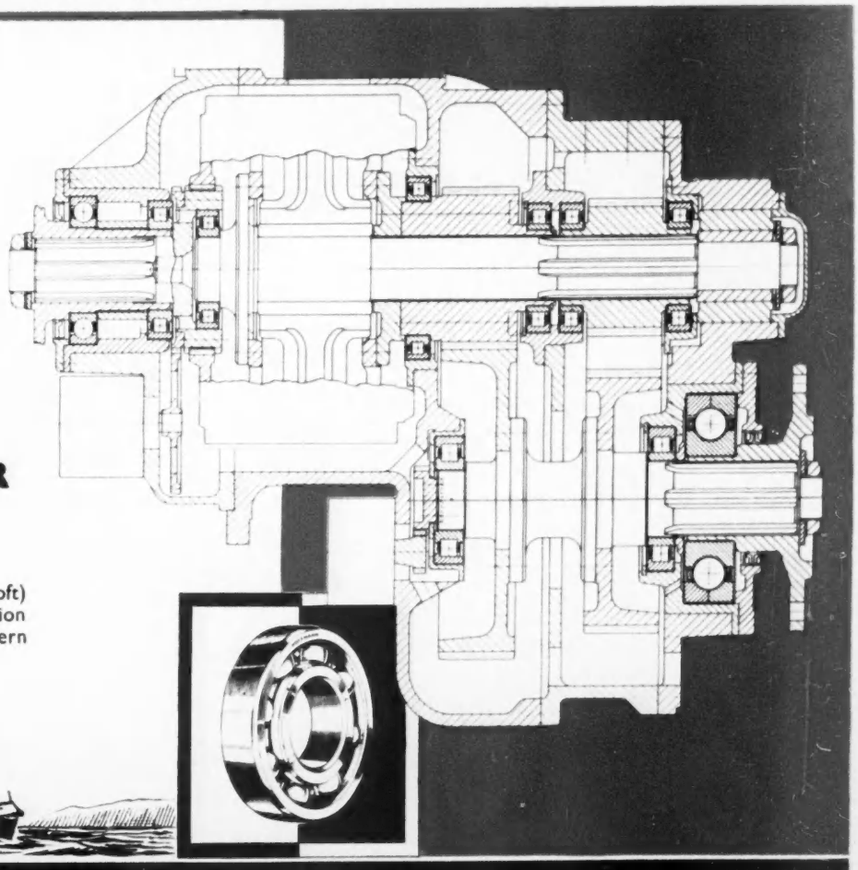
PRINTED BY GEORGE REVEIRS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/10½

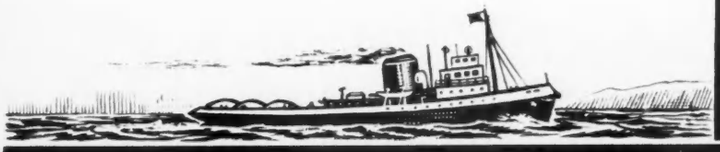
This Oil-operated Marine Gearbox is fitted *exclusively*

with HOFFMANN

BALL AND ROLLER BEARINGS

Designed and built by Transport Equipment (Thornycroft) Limited, this oil-operated gearbox is of robust construction and is designed for heavy duty. Both the ahead and astern clutches can transmit full power continuously.





THE HOFFMANN MANUFACTURING COMPANY LTD., CHELMSFORD, ESSEX

REINFORCED CONCRETE

FOR BUILDING AND ENGINEERING STRUCTURES OF ALL KINDS.

We undertake the complete work, including Design and Construction. At any of our Local Branches, you will find experienced Engineers ready to discuss your requirements.

HOLST & CO LTD

Civil Engineering Contractors, Reinforced Concrete

Head Office: 46 CLARENDON ROAD, WATFORD, HERTS.
Telephone: Watford 34481

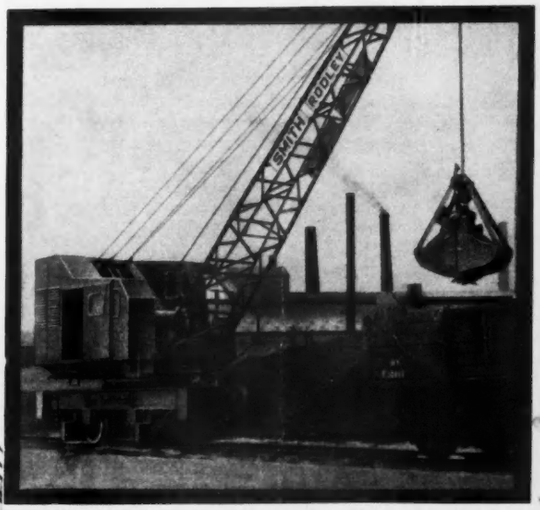
BRANCHES: BIRMINGHAM · MANCHESTER · LEEDS · DURHAM · EDINBURGH · CARDIFF

THE ENGINEER
JUNE 19, 1959

SMITH CRANES

– do the job BETTER!

Smith Cranes employ the newest forms of power and are serving the biggest names in industry, both in the United Kingdom and overseas. Typical of Smith's modern productions is this 25-ton diesel-electric shunting crane, supplied to the Distington Engineering Co. Ltd., shown manoeuvring a large unit of tunnelling mechanism.



A Smith 5-ton diesel shunting crane operating a ring discharge grab to unload from railway wagons at the United Glass Ltd., St. Helens.

THOMAS SMITH & SONS (RODLEY) LTD · CRANE & EXCAVATOR WORKS · RODLEY · LEEDS